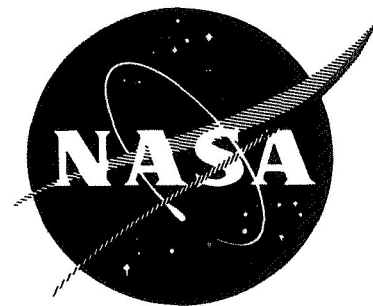


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Research and **T**echnology

Operating

Plan



SUMMARY

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FISCAL YEAR 1971
RESEARCH AND
TECHNOLOGY PROGRAM

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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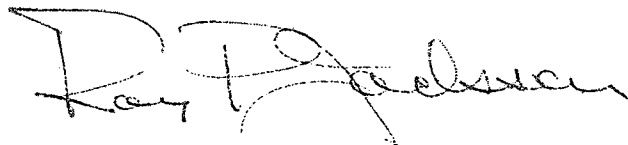
INTRODUCTION

This publication is a summary of the NASA Research and Technology program for FY 1971. It is a compilation of the "Summary" portions of each of the RTOPs (Research and Technology Operating Plan) used for management review and control of research currently in progress throughout NASA. The RTOP Summary is designed to facilitate communication and coordination among concerned technical personnel in government, in industry, and in universities. We believe also that this publication can help to expedite the technology transfer process.

Responsible technical monitors are indicated on the RTOP summaries. Although personal exchanges of a professional nature are encouraged, your consideration is requested in avoiding excessive contacts which might be disruptive to on-going research and development.

Any comments or suggestions you may have to help us evaluate or improve the effectiveness of the RTOP Summary would be appreciated. These should be forwarded to:

National Aeronautics and Space Administration
Office of Advanced Research and Technology
Resources and Institutional Management Division (RMS)
Washington, D.C. 20546

A handwritten signature in dark ink, appearing to read "Roy P. Jackson". The signature is fluid and cursive, with the first name "Roy" being particularly prominent.

Roy P. Jackson
Associate Administrator for
Advanced Research and Technology

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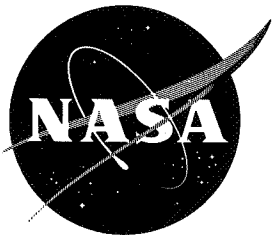
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RESEARCH AND TECHNOLOGY OPERATING PLAN

a summary

FISCAL YEAR 1971

RTOP NO. 120-05-01 TITLE: NUCLEAR FLIGHT SAFETY RESEARCH AND
ANALYSIS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS RTOP ARE: (1) TO CONDUCT RESEARCH THAT WILL PERMIT ACCURATE AND AUTHORITATIVE PREDICTIONS OF REENTRY CONDITIONS FOR NUCLEAR SPACE POWER SYSTEMS, (2) TO CONDUCT RESEARCH LEADING TO THE ULTIMATE DEVELOPMENT OF NUCLEAR SPACE POWER SYSTEM INTACT REENTRY AND GROUND IMPACT VEHICLES, AND (3) TO PARTICIPATE IN AND PROVIDE SUPPORT FOR THE JOINT DOD/AEC/NASA NUCLEAR FLIGHT SAFETY REVIEW AND EVALUATIONS. TIME-TO-MELT AND HEATING RATE EXPERIMENTS WILL BE PERFORMED ON THERMALLY SCALED MODELS AT APPROPRIATE ARC JET TEST CONDITIONS. CANDIDATE CONFIGURATIONS WILL BE TESTED IN SHOCK TUNNELS AND WIND TUNNELS. RESULTS WILL BE APPLICABLE TO RADIOISOTOPE AND FISSION REACTOR POWER SYSTEMS THAT ARE CANDIDATES FOR MANNED AND UNMANNED SPACE OPERATIONS.

RTOP NO. 120-05-03 TITLE: DETECTION OF HEAT SOURCES AND SMALL FIRES
BY AIRBORNE THERMAL INFRARED LINE SCANNERS

ORGANIZATION: NASA HEADQUARTERS

MONITOR: KERR, T. B. TEL. 202-962-0026

TECHNICAL SUMMARY

RADIOISOTOPE-FUELED NUCLEAR HEAT SOURCES PRESENT A POTENTIAL HAZARD FROM DIRECT RADIATION AND/OR FUEL RELEASE AFTER RETURN FROM ORBIT. THE LOCATION AND RECOVERY OF THESE SOURCES FOLLOWING LAND IMPACT COULD BE SIMPLIFIED IF IT IS POSSIBLE TO USE THE HEAT GENERATED BY THE RADIOISOTOPE FUEL AS A LOCATION AID. THE FOREST FIRE RESEARCH LABORATORY OF THE FOREST SERVICE IS USING INFRARED DETECTORS TO LOCATE SMALL FOREST FIRES. THIS TASK WILL UTILIZE EXISTING TECHNOLOGY TO DETERMINE FEASIBILITY OF USING THE SAME TYPE OF EQUIPMENT IN PARALLEL WITH NUCLEAR DETECTORS FOR LOCATING NUCLEAR SOURCES.

RTOP NO. 120-05-04 TITLE: RECOVERY AIDS FOR AEROSPACE NUCLEAR
SYSTEMS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DEVELOP UNDERWATER SOUND GENERATORS AND DETECTION DEVICES THAT WILL PERMIT ACCURATE LOCATION OF NUCLEAR ELECTRICAL POWER SYSTEMS IN SEA WATER. THE SENSOR DESIGN WILL BE CAREFULLY ASSESSED TO ASSURE RELIABLE OPERATION AFTER VEHICLE REENTRY AND FREE-FALL WATER IMPACT.

RTOP NO. 120-05-05 TITLE: REACTOR SAFETY TECHNOLOGY

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-1111

TECHNICAL SUMMARY

RESEARCH WILL BE CONDUCTED THAT WILL PERMIT PREDICTION OF AEROTHERMODYNAMICS AND FLIGHT DYNAMICS OF NUCLEAR REACTOR SYSTEMS ENTERING THE EARTH'S ATMOSPHERE. ANALYTICAL AS WELL AS EXPERIMENTAL WORK WILL BE CONDUCTED TO DETERMINE THE CRITICAL ENTRY CONDITIONS AND CANDIDATE SHIELDING MATERIALS FOR USE AS ABLATORS. ARC-JETS WILL BE USED TO OBTAIN EXPERIMENTAL RESULTS. POTENTIALLY, THE RESEARCH WILL LEAD TO THE DEVELOPMENT OF MINIMUM WEIGHT STRUCTURES TO SERVE AS BOTH BIOLOGICAL AND THERMAL PROTECTION SHIELDS. ULTIMATELY THE WORK WILL PROVIDE THE TECHNOLOGY TO PERMIT THE DESIGN OF NUCLEAR REACTOR SYSTEMS TO SAFELY ENTER THE EARTH'S ATMOSPHERE.

RTOP NO. 120-26-11 TITLE: MERCURY ELECTRON BOMBARDMENT ION THRUSTER
R/T

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: RICHLEY, E. A. TEL. 216-433-6207

TECHNICAL SUMMARY

THE BROAD OBJECTIVE OF THE WORK DESCRIBED HEREIN IS TO PROVIDE THE BASIC RESEARCH AND TECHNOLOGY PROGRAMS NECESSARY TO ENSURE ORDERLY AND MEANINGFUL ADVANCES IN THE STATE-OF-THE-ART OF ELECTROSTATIC THRUSTERS. THE OVERALL PROGRAM IS DIRECTED AT OBTAINING A MORE THOROUGH UNDERSTANDING OF THE BASIC PHYSICAL PROCESSES OCCURRING IN ELECTROSTATIC THRUSTERS BY CONDUCTING PERTINENT EXPERIMENTAL AND ANALYTIC STUDIES; APPLYING THE KNOWLEDGE GAINED TO THE DESIGN, FABRICATION AND TESTING OF NEW THRUSTER COMPONENTS; INTEGRATION PROMISING NEW COMPONENTS INTO THRUSTERS SIZED FOR WIDEST POSSIBLE APPLICATIONS; EVALUATING THRUSTER PERFORMANCE AND LIFE, AND, FURTHER DEVELOPING PARTICULAR THRUSTERS INTO POTENTIAL FLIGHT-TYPE UNITS. IN ADDITION, STUDIES AND INVESTIGATIONS INTO SYSTEMS INTEGRATION PROBLEMS ARE CONDUCTED TO THE EXTENT NECESSARY TO CLEARLY DEFINE THRUSTER INTERFACE PROBLEM AREAS. SPECIFIC PROGRAMS ARE AIMED AT PROVIDING; LOW VOLTAGE MERCURY BOMBARDMENT THRUSTERS SIZED FOR POSSIBLE APPLICATION FOR PRIMARY ELECTRIC PROPULSION AND FOR ATTITUDE CONTROL AND STATION KEEPING. ANOTHER SPECIFIC PROGRAM IS TO PROVIDE A QUALIFIED DEFLECTABLE CESIUM CONTACT IONIZATION THRUSTER FOR LONG-DURATION ATTITUDE CONTROL AND STATION KEEPING.

RTOP NO. 120-26-12 TITLE: ADVANCED ELECTRIC THRUSTER RESEARCH
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SEIKEL, G. R. TEL. 216-433-4000
TECHNICAL SUMMARY

OBJECTIVE: TO STUDY ADVANCED ELECTRIC THRUSTERS THAT SHOW PROMISE FOR SPACE MISSIONS. INVESTIGATIONS ARE AIMED AT UNDERSTANDING THE PHYSICS OF THE PROCESSES IN THE THRUSTERS, ACHIEVING EFFICIENT PERFORMANCE, AND DELINEATING MEANS FOR OBTAINING LONG LIFE, LIGHT WEIGHT, AND RELIABLE THRUSTER SYSTEMS. APPROACH: ANALYTICAL STUDIES AND EXPERIMENTAL STUDIES WHICH INCLUDE EXTENSIVE DIAGNOSTICS AS WELL AS THRUST AND ENERGY EFFICIENCY MEASUREMENTS. LIFETIME AND SYSTEM COMPONENT PROBLEMS WILL ALSO BE INVESTIGATED. ADVANCED ELECTRIC THRUSTERS FOR BOTH HIGH AND LOW POWER WILL BE INVESTIGATED.

RTOP NO. 120-26-13 TITLE: RESISTOJET SYSTEMS TECHNOLOGY FOR MANNED
SPACE STATION REACTION CONTROL

ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE A BACKGROUND OF INFORMATION FROM WHICH A FLIGHT-QUALIFIED, ELECTRO-THERMAL (RESISTOJET) SYSTEM CAN BE DESIGNED, AND TO CARRY THE RESISTOJET TECHNOLOGY TO THE POINT OF PREQUALIFYING A PROTOTYPE THRUSTER FOR SPACE USE. THE TECHNOLOGY DEVELOPMENT WILL INCLUDE: DESIGNING ELECTRO-THERMAL THRUSTERS FOR USE WITH BIOWASTE AND LIGHT PROPELLANT GASES, VERIFICATION OF POTENTIAL THEORETICAL PERFORMANCE AND STRUCTURAL DESIGN CONSIDERATION TO WITHSTAND LAUNCH AND SPACE CONDITIONS. IN ADDITION, FUTURE PROGRAMS WILL INCLUDE ENVIRONMENTAL AND FUNCTIONAL QUALIFICATION AUXILIARY SYSTEMS SUCH AS VALVES, POWER CONDITIONING EQUIPMENT, ETC. SINCE SIGNIFICANT ADVANTAGES MAY RESULT FROM THE USE OF BIOWASTE GASES AND SINCE THE DESATURATION OF THE CONTROL MOMENT GYROS (CMG) IS ONE OF THE PRIME POTENTIAL USES OF THE RESISTOJET SYSTEM, THE RESISTOJET DEVELOPMENT WILL BE CLOSELY COORDINATED WITH LANGLEY'S EFFORTS IN LIFE SUPPORT AND CMG. THE MAJOR PART OF THIS EFFORT WILL BE ACCOMPLISHED THROUGH A SERIES OF RESEARCH AND DEVELOPMENT CONTRACTS, HOWEVER, SOME IN-HOUSE TESTING IS PLANNED. THE ANTICIPATED RESULT OF THIS PROGRAM IS THE DEMONSTRATION OF A LIGHTWEIGHT, HIGH-PERFORMANCE AND RELIABLE THRUSTER SYSTEM FOR SPACE STATION ORBIT KEEPING AND CMG DESATURATUON.

RTOP NO. 120-26-14 TITLE: ADVANCED PLASMA THRUSTER RESEARCH
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

THE MPD ARC STANDS OUT AS THE MOST PROMISING ELECTROMAGNETIC TYPE THRUSTER WITH POTENTIAL ADVANTAGES OVER THE ION ENGINE. ALTHOUGH CONTINUING RESEARCH HAS LEAD TO A FAIR UNDERSTANDING OF THE DEVICE, RESEARCH ALONG SEVERAL LINES IS NEEDED IN ORDER TO PROVE ITS POTENTIAL AND TO INCREASE ITS EFFICIENCY. RESEARCH ON THE MPD ARC BY

SEVERAL GROUPS INDICATES THAT HIGH EFFICIENCY MAY BE ATTAINABLE FOR CONTINUOUS (STEADY) OPERATION AT HIGH POWERS. IT HAS ALSO BEEN INDICATED THAT THE ADVANTAGES OF HIGH POWER OPERATION COULD BE REALIZED FOR MEDIUM AVERAGE POWER BY REPETITIVE PULSING OF LONG (MILLISECS) PULSES WITH HIGH-POWER QUASI-STEADY OPERATION. RESEARCH WILL BE CARRIED OUT, BOTH IN-HOUSE AND UNDER CONTRACT, TOWARD DESIGN AND DEVELOPMENT OF MPD ARCS FOR CONTINUOUS OPERATION AT HIGH POWERS AND REPETITIVE, LONG (MILLISECS) PULSING FOR MEDIUM AVERAGE POWERS. IN ALL EXPERIMENTS ON THE MAGNETOPLASMA DYNAMIC ARC, EFFECTS OF THE TEST ENVIRONMENT ON THE PLASMA FLOW ARE PRESENT TO VARYING DEGREES. INDIVIDUAL INVESTIGATORS DEAL WITH THESE EFFECTS IN DIFFERENT WAYS, AS EACH CONCENTRATES IN ONE OR A FEW AREAS OF STUDY. CONTRACT AND IN-HOUSE RESEARCH WILL CONTINUE CONCENTRATED EFFORT TO IDENTIFY THOSE TEST-ENVIRONMENT SOURCES OF PRIMARY INFLUENCE ON THE JET PLUME IN THE TEST TANK AND SEEK TO ELIMINATE AS MANY AS POSSIBLE SO AS TO APPROACH SPACE-LIKE CONDITIONS.-----

RTOP NO. 120-26-16 TITLE: ELECTRIC PROPULSION SYSTEMS TECHNOLOGY
FOR UNMANNED PLANETARY/INTERPLANETARY
SPACECRAFT

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS ACTIVITY IS THE PREPARATION OF THE TECHNOLOGY OF SOLAR POWERED, ELECTRIC PROPULSION FOR UNMANNED INTERPLANETARY MISSIONS. IT IS BROKEN INTO THREE MAJOR AREAS, TRAJECTORY AND NAVIGATION ANALYSIS, SPACECRAFT-PROPULSION SYSTEM INTERACTIONS, AND PROPULSION SYSTEM TECHNOLOGY DEVELOPMENT. TRAJECTORY AND NAVIGATION ANALYSIS EFFORT IS TO PROVIDE AN EFFICIENT AND VERSATILE TRAJECTORY PERFORMANCE AND NAVIGATION COMPUTATIONAL CAPABILITY, AND TO CARRY OUT PARAMETRIC STUDIES OF THE TRAJECTORY-RELATED PROPERTIES AND NAVIGATION ERROR ANALYSIS STUDIES OF SPECIFIED MISSIONS. AN INTEGRATED SET OF COMPUTER PROGRAMS FOR SYSTEMS ANALYSIS AND MISSION PERFORMANCE STUDIES OF SOLAR-POWERED ELECTRICALLY PROPELLED SPACE VEHICLES IS BEING DEVELOPED AND EXERCISED. LOW-THRUST MISSION ANALYSIS SOFTWARE DEVELOPMENT IS CONTINUING. PROGRAMS WILL BE EXERCISED ON SPECIFIC MISSION APPLICATIONS TO PROVE THEIR APPLICABILITY, AND DEVELOPED TECHNOLOGIES WILL BE APPLIED TO PRELIMINARY MISSION STUDIES. PROPULSION SYSTEM TECHNOLOGY DEVELOPMENT EFFORT IS AIMED AT THE DEMONSTRATION BY FY'71 OF A COMPLETE BREADBOARD PROPULSION SYSTEM INCORPORATING ALL FUNCTIONAL AND PERFORMANCE REQUIREMENTS OF A MISSION SPACECRAFT SYSTEM. THIS INCLUDES CLOSED-LOOP, VARIABLE POWER OPERATION WITH THREE-AXIS ATTITUDE CONTROL AND AUTOMATIC FAILURE DETECTION AND CORRECTION. THE TEST SYSTEM CONSISTS OF THREE 2 1/2 KW HOLLOW CATHODE MERCURY BOMBARDMENT ION ENGINES, INDIVIDUALLY GIMBAL MOUNTED TO A STRUCTURE WHICH TRANSLATES IN TWO DIRECTIONS. TWO POWER CONDITIONING UNITS CONNECT TO THE THRUSTERS THROUGH A SWITCHING NETWORK PERMITTING INTERCONNECTION OF ANY THRUSTER WITH EITHER POWER CONDITIONER. SIMULATED SPACECRAFT CONTROL AND COMMAND ARE UTILIZED.

RTOP NO. 120-26-17 TITLE: AUXILIARY PROPULSION SYSTEMS TECHNOLOGY
FOR UNMANNED SPACECRAFT

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: ISLEY, W. C. TEL. 301-982-6389

TECHNICAL SUMMARY

FUTURE REQUIREMENTS FOR AUXILIARY PROPULSION OF UNMANNED SPACECRAFT WILL BE CONTINUALLY ANALYZED USING AVAILABLE PLANNING TOOLS SUCH AS FUTURE MISSION MODELS, "OBJECTIVES & GOALS IN SPACE SCIENCE & APPLICATIONS" (MASR SP-162), OSSA PROSPECTUS, AND OTHER SOURCES OF PROSPECTIVE MISSION REQUIREMENTS. THESE ANALYSES WILL BE FORMALIZED AND UTILIZED TO DETERMINE APPROPRIATE CANDIDATE THRUSTER SYSTEMS AND PROPER PROGRAM TIMING. THE PROPOSED THRUSTER SYSTEMS INCLUDING THE EFFECTS ON SPACECRAFT, WILL BE COMPARATIVELY EVALUATED BOTH ANALYTICALLY AND EXPERIMENTALLY VIA GROUND TESTING IN THE GSFC ELECTRIC PROPULSION SIMULATOR. IN ADDITION, SPACE TESTS SUCH AS THOSE OF THE RESISTOJET AND ION ENGINE ON ATS WILL BE CONDUCTED AS REQUIRED TO ASSESS SYSTEM PERFORMANCE RELATING TO THE PROPULSION FUNCTIONS IDENTIFIED IN THE ANALYSES. ALTHOUGH THE PRINCIPAL THRUSTER TECHNOLOGY MAY BE DERIVED FROM RESEARCH EFFORTS CONDUCTED ELSEWHERE, E.G., LEWIS RESEARCH CENTER, USAF, OR JET PROPULSION LABORATORY, IT IS ANTICIPATED THAT CRITICAL SYSTEMS TECHNOLOGY WILL NOT BE AVAILABLE FROM SUCH EFFORTS. SUCH SYSTEMS DEVELOPMENT WILL BE CLOSELY TIED TO SPECIFIC MISSION MODELS AND WILL INCLUDE INTERFACE CONSTRAINTS AS WELL AS BASIC PERFORMANCE REQUIREMENTS. THIS WILL INVOLVE RELATED RESEARCH AS REQUIRED ON SELECTED SYSTEMS.

RTOP NO. 120-26-18 TITLE: PHYSICAL PROCESSES IN PLASMA PROPULSION

ORGANIZATION: NASA HEADQUARTERS

MONITOR: MULLIN, J. P. TEL. 202-962-0041

TECHNICAL SUMMARY

PLASMA THRUSTERS OFFER PROMISE FOR FUTURE ELECTRIC PROPULSION APPLICATION WITH SIMPLER SYSTEMS THAN PRESENTLY AVAILABLE. DEVELOPMENT OF SUCH SYSTEMS HAS BEEN HANDICAPPED BY A LACK OF UNDERSTANDING OF THE PHYSICAL PROCESSES INVOLVED IN EFFICIENT PLASMA ACCELERATION. THE PROPOSED RESEARCH IS AIMED AT INCREASING UNDERSTANDING OF THE PULSED AND STEADY FLOW PHENOMENON EXPERIENCED IN SUCH DEVICES. THE CONTINUATION OF THEORETICAL AND EXPERIMENTAL STUDY OF APPROPRIATE ACCELERATORS PRESENTLY BEING CARRIED OUT BY UNIVERSITY BASED INVESTIGATORS FUNDED UNDER NASA RESEARCH GRANTS IS PROPOSED.

RTOP NO. 120-26-19 TITLE: INTEGRATED EC/LS-RESISTOJET SYSTEM
TECHNOLOGY DEVELOPMENT AND DEMONSTRATION

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

STUDIES CONCERNING THE USE OF RESISTOJETTS FOR SPACE STATION CMG DESATURATION AND ORBIT KEEPING HAVE SHOWN THAT THIS APPROACH OFFERS CONSIDERABLE PROMISE. THE OPERATION OF THE RESISTOJETTS USING GASES RESIDUAL TO THE ENVIRONMENTAL CONTROL/LIFE SUPPORT SYSTEMS COULD RESULT IN CONSIDERABLE SAVINGS IN PROPELLANT RESUPPLY WEIGHT

WHEREAS THE TECHNOLOGY FOR THE DEVELOPMENT OF THE RESISTOJET THRUSTERS IS PROCEEDING WELL UNDER A SEPARATE PROGRAM, ESSENTIALLY NO WORK HAS BEEN DIRECTED TOWARD THE DEVELOPMENT OF THE COMPLETE SYSTEM REQUIRED TO UTILIZE BIOWASTE GASES. THE OBJECTIVE OF THIS PROGRAM IS TO INCORPORATE THE ONGOING BIOWASTE RESISTOJET TECHNOLOGY INTO AN INTEGRATED ENVIRONMENTAL CONTROL/LIFE SUPPORT-RESISTOJET-CMG SYSTEM DEMONSTRATION PROGRAM. IN THIS PROGRAM RESISTOJETS WOULD BE OPERATED USING GASES RESIDUAL TO A SABATIER TYPE OXYGEN REGENERATION SYSTEM ON A DUTY CYCLE DICTATED BY CMG DESATURATION AND DRAG MAKEUP REQUIREMENTS FROM A HYPOTHETICAL SPACE STATION IN A PARTICULAR ORBIT AND ORIENTATION. SUBSEQUENTLY, THE MEASURED PERFORMANCE OF THE THRUSTER SYSTEM WOULD BE INTEGRATED INTO THE CMG COMPUTER PROGRAM TO VERIFY THAT DELIVERED PERFORMANCE, RESPONSE, AND SYSTEM RELIABILITY WERE ADEQUATE TO MEET THE DESATURATION AND ORBIT KEEPING REQUIREMENTS. TO ACCOMPLISH THE SYSTEM DEMONSTRATION, THE MAJOR PREPARATORY EFFORT INVOLVES THE SYSTEM TO COLLECT, CONDITION AND FEED THE BIOWASTE GASES TO THE RESISTOJET THRUSTERS. HOWEVER, BEFORE THIS EFFORT CAN BE INITIATED, QUESTIONS REGARDING PROBABLE DUTY CYCLES, DEGREE OF SIMULATION, TYPE OF TEST FACILITY, ETC., MUST BE ANSWERED.

RTOP NO. 120-26-20 TITLE: SOLAR-ELECTRIC MULTIMISSION SPACECRAFT
(SEMMS)

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THE LONG-RANGE OBJECTIVE OF THIS EFFORT IS TO DEVELOP AND FLIGHT TEST A SOLAR ELECTRIC PROPULSION (SEP) SPACECRAFT HAVING IDENTIFIABLE MULTI-MISSION CHARACTERISTICS, WITH A LAUNCH IN THE MID-1970'S TIME PERIOD. THE SHORT-RANGE (FY 71) OBJECTIVE IS TO ACCOMPLISH PHASE A (PRELIMINARY ANALYSIS) PROJECT PLANNING TO ENABLE A FY 1972 NEW START OF THE PROJECT. STUDIES HAVE INDICATED THAT FOR CERTAIN MISSIONS ADVANTAGES MAY ACCRUE FROM THE APPLICATION OF SEP. THESE ADVANTAGES RESULT FROM THE HIGH PERFORMANCE OF ELECTRIC PROPULSION, AND THEY INCLUDE INCREASED CAPABILITY AND FLEXIBILITY TO PERFORM MISSIONS WITH EXISTING LAUNCH VEHICLES, REDUCTION OF FLIGHT TIME, INCREASED OBSERVATION TIME IN REGIONS OF MAXIMUM INTEREST, ADDITIONAL PAYLOAD, UTILIZATION OF LESS COSTLY LAUNCH VEHICLES, AND PROVISION OF AN ALTERNATIVE TO DEVELOPING NEW LAUNCH VEHICLES OR STAGES. IN ADDITION DEVELOPMENT OF SEP WILL FACILITATE NASA'S LONG-RANGE PROGRAM TO DEVELOP NUCLEAR-ELECTRIC PROPULSION. THIS TECHNOLOGY FLIGHT WILL ACHIEVE THREE MAJOR ACCOMPLISHMENTS: (1) BY MEANS OF FLIGHT DEMONSTRATION, REDUCE THE RISK OF APPLYING SEP BEFORE MAKING MAJOR PROGRAM COMMITMENTS; (2) PROVIDE A BASIC CAPABILITY DIRECTLY USABLE FOR A NUMBER OF MISSIONS OF INTEREST IN THE LATE 70'S AND IN THE 80'S; (3) CONTINUE A RATIONAL PROGRESSION OF TECHNOLOGY TOWARD HIGHER PERFORMANCE SYSTEMS WITH BROAD UTILITY. DEVELOPMENT AND FLIGHT TEST OF AN SEP SPACECRAFT IS CONSIDERED TIMELY BECAUSE THE TECHNOLOGY IS IN AN ADVANCED STATE AND BECAUSE ADDITIONAL GROUND TESTING WILL PRODUCE DIMINISHING RETURNS. IN FY 71, PHASE A STUDIES WILL BE ACCOMPLISHED, AND A BASIC UNDERSTANDING OF ALL SEP-RELATED TECHNOLOGY WILL HAVE BEEN ACHIEVED BY THE END OF THE FISCAL YEAR. MULTI-MISSION CAPABILITY WILL ALSO BE DEFINED IN FY 71. TO MAKE

MAXIMUM PRACTICABLE USE OF ADVANCED SUB-SYSTEMS WHICH WILL BE AVAILABLE IN THE PERIOD OF THIS PROJECT, TWO BASIC IMPLEMENTATION APPROACHES, MAKING USE OF MARINER VENUS MERCURY TECHNOLOGY AND OF OUTER-PLANETS TECHNOLOGY, WILL BE CONSIDERED.

RTOP NO. 120-26-21 TITLE: ADVANCED PULSED DISCHARGE THRUSTER
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS THE DEVELOPMENT OF AN IMPROVED PERFORMANCE ATTITUDE CONTROL TORQUING SYSTEM FOR LONG TERM PLANETARY EXPLORATION. THE LONG RANGE OBJECTIVE IS TO DEVELOP A PULSED PLASMA THRUSTER CAPABLE OF SUPPLYING THRUST IN THE MICROPOUND-TO-MILLIPOUND RANGE, TO PROVIDE ALL ATTITUDE CONTROL IMPULSE REQUIREMENTS. THE SYSTEM WILL BE APPLICABLE TO PLANETARY MISSIONS SUCH AS MULTIPLANET FLYBYS AND TO THE THERMOELECTRIC OUTER PLANET SPACECRAFT (TOPS) PROJECT. THE MAIN ADVANTAGES OF THIS APPROACH WILL BE HIGH RELIABILITY FOR 10 TO 12 YEARS OF OPERATION, LOW HARDWARE WEIGHT, LOW POWER CONSUMPTION AND HIGH SPECIFIC IMPULSE, IN THE RANGE OF 1000 TO 1500 SEC. IN THE MICROPOUND REGION. AN ESTIMATED WEIGHT REDUCTION FROM 81 TO 19 LBS. AND A POWER REDUCTION FROM 20 TO 6 WATTS HAS BEEN SHOWN POSSIBLE FOR THE TOPS BASELINE CONFIGURATION. THIS PROGRAM WILL BE CONDUCTED JOINTLY WITH THE GODDARD SPACE FLIGHT CENTER, WHERE PULSED PLASMA EVALUATION AND DEVELOPMENT PROGRAMS FOR MICROPOUND THRUSTERS ARE BEING CONDUCTED UNDER NASA RTOP 120-26-17. IN ADDITION, THE CONTROL SYSTEMS ANALYSIS AND ELECTRONIC DESIGN REQUIRED FOR THE TOPS PROJECT WILL BE CONDUCTED UNDER THE JPL TOPS PROJECT (RTOP 186-68-54). THE PROGRAM WILL BE PERFORMED DURING FY 71, 72 AND 73, AND INCLUDES BOTH CONTRACTED AND IN-HOUSE ACTIVITIES, COVERING THE THRUSTER DEVELOPMENT, SUITABLE ATTITUDE CONTROL SYSTEM DESIGN AND TESTING, AND SPACECRAFT INTERFACE TESTING. FOR FY '71 THE FOLLOWING OBJECTIVES WILL BE PURSUED (1) THE DESIGN AND FABRICATION OF THE MICROPOUND THRUSTER, (2) MILLIPOUND THRUSTER FEASIBILITY DEMONSTRATION, (3) THE ATTITUDE CONTROL SYSTEM DESIGN AND TESTING.

RTOP NO. 120-26-22 TITLE: STUDY OF SOLAR-ELECTRIC
SPACECRAFT/MISSIONS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: FOSTER, J. V. TEL. 415-961-2267
TECHNICAL SUMMARY

A PHASE A (PRELIMINARY ANALYSIS) STUDY WILL BE CONDUCTED TO DEFINE SUITABLE MISSIONS FOR A SOLAR ELECTRIC SPACECRAFT AND TO DETERMINE THE EXTENT OF UTILIZING PIONEER SPACECRAFT TECHNOLOGY IN THE DEFINITION OF SUCH A SPACECRAFT. AMONG MISSIONS TO BE STUDIED WILL BE AN ASTEROID FLYTHROUGH AND A COMET RENDEZVOUS. MAXIMUM USE WILL BE MADE OF THE PIONEER F/G JUPITER SPACECRAFT SUBSYSTEMS AND COMPONENTS; HOWEVER, THE EXTERNAL CONFIGURATION WILL DEPART SIGNIFICANTLY FROM THE PIONEER F/G SPACECRAFT.

RTOP NO. 120-27-07 TITLE: NUCLEAR ELECTRIC POWER GENERATION STUDIES
ORGANIZATION: NASA HEADQUARTERS
MONITOR: LYNCH, J. J. TEL. 202-962-0091
TECHNICAL SUMMARY

ANALYTICAL STUDIES WILL BE PERFORMED DEALING WITH THE DESIGN AND OPERATION OF NUCLEAR HEAT SOURCES AND/OR POWER CONVERSION SYSTEMS. THE PURPOSE OF THE STUDIES WILL BE TO PROVIDE INFORMATION USEFUL FOR NUCLEAR POWER SYSTEMS PROGRAM PLANNING. ADVANCED DESIGN NUCLEAR REACTOR AND ISOTOPE HEAT SOURCES WILL BE INVESTIGATED AS WILL DIRECT THERMAL-TO-ELECTRICAL ENERGY CONVERSION APPROACHES SUCH AS THERMIONIC, THERMOELECTRIC, AND MHD CONVERTERS.

RTOP NO. 120-27-10 TITLE: SMALL BRAYTON ENGINE (2-15 KWE)
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: PACKE, D. R. TEL. 216-433-4000
TECHNICAL SUMMARY

THE SMALL BRAYTON ENGINE PROGRAM IS TO PROVIDE A HIGHLY RELIABLE, LONG-LIFE SPACE POWER SYSTEM WITH ELECTRICAL POWER OUTPUT OF FROM 2 TO 15 KWE DEPENDING ON THE HEAT SOURCE AND MISSION REQUIREMENTS. TYPICAL MISSIONS FOR THIS ENGINE WOULD INCLUDE MANNED SPACE STATIONS, MANNED LUNAR MISSIONS, AND UNMANNED MISSIONS REQUIRING POWER LEVELS ABOVE A FEW KILOWATTS. THE ENGINE PROGRAM IS TO INCLUDE THE INVESTIGATION OF AN ISOTOPE HEAT SOURCE FOR USE AT THE 6 KWE ENGINE OUTPUT POWER LEVEL. THE BRAYTON ENGINE PROGRAM AT LEWIS RESEARCH CENTER IS A COMBINED IN-HOUSE-CONTRACTOR EFFORT WHERE RESPONSIBILITY FOR THE SYSTEM DESIGN, COMPONENT SPECIFICATIONS, SOME COMPONENT DESIGN, ENGINE ASSEMBLY, AND TESTING IS PERFORMED IN-HOUSE; AND WHERE CONTRACTORS ARE RESPONSIBLE FOR MOST DETAILED COMPONENT DESIGN, FABRICATION, AND LIMITED COMPONENT TESTING. THE TECHNOLOGY PROGRAM PRESENTLY INCLUDES AN ENGINE, ONE MODULE OF WHICH PRODUCES 2-15 KILOWATTS OF ELECTRIC POWER. THIS ENGINE IS PRESENTLY UNDERGOING PERFORMANCE AND ENDURANCE TESTING IN THE PLUM BROOK SPACE POWER FACILITY USING AN ELECTRICALLY HEATED HEAT SOURCE. WHEN THE ISOTOPE HEAT SOURCE IS READY FOR GROUND TESTING, IT WILL BE MATED TO THE SMALL ENGINE AND TESTED IN THE PLUM BROOK SPACE POWER FACILITY. IF THE REACTOR BRAYTON IS CHOSEN FOR THE 1977 SPACE STATION, THE SMALL BRAYTON ENGINE MAY BE MODIFIED FOR OPERATION WITH THE ZIRCONIUM-HYDRIDE (SNAP-8) REACTOR.

RTOP NO. 120-27-13 TITLE: ADVANCED NUCLEAR RANKINE POWER SYSTEMS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ENGLISH, R. E. TEL. 216-433-6949
TECHNICAL SUMMARY

TO DEVELOP TECHNOLOGY FOR HIGH-TEMPERATURE ALKALI-METAL NUCLEAR RANKINE SPACE ELECTRIC POWER SYSTEMS TO BE USED AS AUXILIARY POWER OR FOR ELECTRIC PROPULSION MISSIONS AFTER 1980. TECHNOLOGY WILL BE ESTABLISHED FOR INDIVIDUAL ENGINE COMPONENTS FOLLOWED BY THE INTEGRATION OF THE COMPONENTS INTO A COMPLETE SYSTEM. A NOMINAL 300 KWE POTASSIUM RANKINE SYSTEM HAS BEEN DEFINED, AND SUPPORTING TECHNOLOGY AND COMPONENT DEVELOPMENT ARE BEING PURSUED.

RTOP NO. 120-27-14 TITLE: THERMIONIC AND THERMOELECTRIC CONVERSION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: BREITWIESER, R. TEL. 216-433-4000
TECHNICAL SUMMARY

RADIOISOTOPE AND NUCLEAR POWERED THERMOELECTRIC AND THERMIONIC SYSTEMS ARE OF INTEREST FOR SPACE POWER GENERATION. SUPPORT OF THE AEC PROGRAM FOR INPILE THERMIONICS WILL CONTINUE ALTHOUGH THIS HAS ALWAYS BEEN RECOGNIZED AS A DIFFICULT REACTOR CONCEPT TO DEVELOP. ADVANCES OVER THE PAST DECADE IN REFRACTORY METALS, HEAT PIPES, AND LOWER TEMPERATURE OPERATION OF THERMIONIC CONVERTERS PERMIT CONSIDERATION OF AN OUT-OF-PILE CONCEPT WITH GOOD PERFORMANCE WHICH COULD BE SUBSTANTIALLY EASIER TO DEVELOP. TECHNOLOGY WORK WILL CONTINUE ON FUELS, CONVERTORS AND THERMOCOUPLES, MOST OF WHICH (80 PERCENT) SUPPORTS BOTH THE OUT-OF-PILE AND AEC IN-PILE CONCEPTS. ATTENTION, HOWEVER, WILL BE FOCUSED ON THE OUT-OF-PILE CONCEPT. THERMIONIC NUCLEAR FUEL WORK WILL EMPHASIZE FUEL FORM STABILITY. THE EFFECT OF THERMAL CYCLING ON DIMENSIONAL STABILITY WILL BE STUDIES. UO₂ AND UC FUEL PIN DISTORTION FROM FISSION GAS EVOLUTION WILL BE TREATED ANALYTICALLY AND EXPERIMENTALLY. THERMIONIC CONVERTER APPROACH WILL EMPHASIZE ENHANCED PERFORMANCE AT LOW SOURCE TEMPERATURE BY IMPROVED EMITTER AND COLLECTOR MATERIALS. EMITTER AND COLLECTOR SYSTEMS WILL BE CHARACTERIZED AND TESTED FOR PERFORMANCE AND LIFE. HEAT PIPE HEAT TRANSFER SYSTEMS AND CERAMIC TO METAL TRILAYEN INSULATORS SUITABLE FOR OUT-OF-CORE SYSTEMS WILL BE TESTED. COMPLETE OUT-OF-CORE THERMIONIC CONVERTER MODULES WILL BE DESIGNED AND TESTED TO STUDY COMPONENT INTERACTIONS. THE THERMOELECTRIC PROGRAM WILL INVESTIGATE THE DEVELOPMENT OF HIGH TEMPERATURE THERMOELECTRIC CONVERTER COUPLED TO A RADIOISOTOPE HEAT SOURCE. A HYBRID THERMOCOUPLE CONSISTING OF SEGMENTED SILICON-GERMANIUM/LEAD TELLURIDE LEGS WILL BE TESTED TO ESTABLISH EFFICIENCY AND RELIABILITY. THE BRAYTON SYSTEM RADIOISOTOPE FUEL CAPSULES WILL BE USED AS A REFERENCE HEAT SOURCE.

RTOP NO. 120-27-15 TITLE: NUCLEAR POWER REACTOR TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: KAUFMAN, S. J. TEL. 216-433-6691
TECHNICAL SUMMARY

RESEARCH IS BEING CONDUCTED TO DEVELOP THE TECHNOLOGY THAT WILL BE REQUIRED TO CONSTRUCT AND OPERATE AN ADVANCED COMPACT FAST REACTOR TO BE USED AS THE HEAT SOURCE FOR A POWER GENERATION SYSTEM. THE GOALS OF THE PROGRAM ARE TO OBTAIN ANALYTICAL AND EXPERIMENTAL SOLUTIONS TO THE PROBLEMS ASSOCIATED WITH THE REACTOR AND TO GENERATE THE NECESSARY TECHNOLOGY SO THAT A RELIABLE, LONG LIFE SYSTEM CAN BE DEVELOPED FOR SPACE MISSIONS IN THE 1980 TIME PERIOD. THE LONG RANGE PLANS ARE FOR A REACTOR TO OPERATE WITH COOLANT OUTLET TEMPERATURES IN EXCESS OF 2000 DEGREES F AND A NEAR TERM GOAL (MID 1970'S) OF 1700 DEGREES F. THE THERMAL OUTPUT CAPACITY OF THE REACTOR IS IN EXCESS OF 2 MEGAWATTS. THE MAJOR EFFORT CENTERS AROUND AN IN-PILE FUEL AND MATERIAL TESTING PROGRAM, A FAST SPECTRUM CRITICAL EXPERIMENT AND MATERIALS INVESTIGATIONS. A DECISION WILL BE MADE AT THE END OF FY'73 AS TO WHETHER AN EXPERIMENTAL REACTOR WILL BE BUILT AND TESTED.

RTOP NO. 120-27-17 TITLE: SPACECRAFT ELECTRICAL POWER SYSTEMS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-3285
TECHNICAL SUMMARY

IN THERMOELECTRIC POWER GENERATION THE OBJECTIVES ARE TO INVESTIGATE THE PERFORMANCE CHARACTERISTICS OF ADVANCED RTG CONCEPTS AND DETERMINE THE FEASIBILITY OF APPLICATION OF THESE CONCEPTS TO FUTURE LRC MISSIONS; TO EVALUATE THE OPERATIONAL CHARACTERISTICS OF CASCADED SYSTEMS; AND TO STUDY SOME OF THE HEAT-MANAGEMENT PROBLEMS ASSOCIATED WITH RTG'S. MODULES ARE CURRENTLY BEING TESTED AND OTHERS WILL BE PURCHASED TO AID IN THIS INVESTIGATION. IN SOLAR POWER THE OBJECTIVES ARE TO DEVELOP AND TO PROVIDE THE BASIC SOLAR POWER TECHNOLOGY LEADING TO RELIABLE, LIGHTWEIGHT SOLAR ARRAYS FOR SPACE PROGRAMS. SPECIFIC OBJECTIVES INCLUDE SUFFICIENT PARAMETRIC TESTS ON THE ELECTRICAL AND PHYSICAL PROPERTIES OF IMPROVED SOLAR CELLS TO PERMIT OPTIMUM DESIGN OF SOLAR POWER SYSTEMS, AND THE DEVELOPMENT OF A LOW-COST, RADIATION-RESISTANT, TRANSPARENT SHIELD FOR SOLAR CELLS. IN POWER CONDITIONING THE BROAD OBJECTIVE IS TO IMPROVE CIRCUITRY RELIABILITY AND EFFICIENCY OF CONVERTERS, REGULATORS, AND BATTERY CHARGE CONTROL DEVICES. ALSO INCLUDED IN THIS PROGRAM IS A LIMITED AMOUNT OF RADIATION STUDY AT THE CIRCUIT AND COMPONENT LEVEL TO DETERMINE THE EFFECTS OF RADIATION VERSUS OVERALL PERFORMANCE. WASTE-HEAT MANAGEMENT FOR USEFUL PURPOSES AND METHODS OF TRACKING TO UTILIZE THE MAXIMUM POWER OF VARIOUS TYPES OF POWER SOURCES WILL ALSO BE INVESTIGATED.

RTOP NO. 120-27-20 TITLE: THERMOELECTRIC SYSTEM TECHNOLOGY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: EPSTEIN, J. TEL. 301-982-4564
TECHNICAL SUMMARY

THE SUCCESS OF MISSIONS AIMED AT EXPLORING THE OUTER LIMITS OF THE SOLAR SYSTEM WILL DEPEND HEAVILY ON THE AVAILABILITY OF STABLE, LONG TERM RADIOISOTOPE THERMOELECTRIC GENERATORS (RTG). ACCURATE PREDICTIONS FOR LONG TERM PERFORMANCE (>5 YEARS) AND THE PRECISE DEFINITIONS OF THE RTG CREATED ENVIRONMENT ARE REQUIRED. LIFE TEST AND EVALUATION OF SEVERAL RTG CONCEPTS AND SPACECRAFT EXPERIMENTS FOR RADIATION AND MAGNETIC ENVIRONMENTAL COMPATIBILITY ARE THE TASKS REQUIRED TO ENHANCE THE SUCCESS PROBABILITY OF THESE MISSIONS. THE PROCESSES INVOLVED IN THE INTERACTIONS WITHIN THE RTG MUST BE DETERMINED AND CONTROLLED. THE DEVELOPMENT OF METHODS FOR MINIMIZING THE ENVIRONMENTAL INTERFERENCE AND THE VERIFICATION OF THESE METHODS BY EMPIRICAL MEANS ARE REQUIRED.

RTOP NO. 120-27-21 TITLE: RTG SPACECRAFT INTEGRATION AND EVALUATION
FOR PLANETARY AND INTERPLANETARY MISSIONS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: FOSTER, J. V. TEL. 415-961-1111
TECHNICAL SUMMARY

AN INVESTIGATION OF RTG-SPACECRAFT INTEGRATION FACTORS IS BEING CONDUCTED SO THAT RADIOISOTOPE POWER SUPPLIES CAN BE UTILIZED TO THE

FULLEST ADVANTAGE AND WITHOUT DEGRADING MISSION OBJECTIVES ON INTERPLANETARY SPACECRAFT SUCH AS PIONEER F/G. THE INVESTIGATION COVERS ELECTRICAL, THERMAL, MECHANICAL, AND RADIATION INTEGRATION WITH SPACECRAFT. METHODS OF RADIATION INTERFERENCE DISCRIMINATION, ELIMINATION, OR COMPENSATION (E.G., TRANSDUCER TYPE AND COMBINATION SELECTION, ENERGY DISCRIMINATION, COINCIDENCE REQUIREMENTS, PULSE SHAPE DISCRIMINATION, PARTIAL SHADOW-SHIELDING, AND ISOTOPE RADIATION SIGNATURE COMPENSATION) ARE BEING INVESTIGATED. METHODS OF THERMAL/MECHANICAL INTEGRATION ARE BEING INVESTIGATED FOR UTILIZATION OF RTG WASTE HEAT BY THE SPACECRAFT TO REDUCE SPACECRAFT POWER REQUIREMENTS ON OUTER PLANET MISSIONS (E.G., THE USE OF DEPLOYABLE HEAT PIPES). ELECTRICAL INTEGRATION INVESTIGATION IS CONCERNED WITH IMPROVING EFFICIENCY OF POWER CONVERSION FROM THE TYPICALLY LOW VOLTAGE OUTPUT RTG'S. GROWTH POTENTIAL OF EXISTING RTG'S IS BEING STUDIED TO DETERMINE WHAT RTG DEVELOPMENTS OR MODIFICATIONS WILL BE NECESSARY TO SUPPORT PROGRAM REQUIREMENTS FOR FUTURE OUTER PLANET MISSIONS SUCH AS FOLLOW-ONS TO PIONEER F/G. FOR THE SAME PURPOSE, THE MULTI-HUNDRED-WATT (MHW) RTG, TO BE DEVELOPED BY THE AEC, WILL BE STUDIED TO DETERMINE APPLICABILITY OF THE MHW, OR DERATED MODIFICATIONS THEREOF, TO PIONEER OUTER PLANET MISSIONS.

RTOP NO. 120-27-40 TITLE: NUCLEAR REACTOR THERMIONIC SYSTEM
TECHNOLOGY

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THE OBJECTIVE OF THE THERMIONIC REACTOR SYSTEMS PROJECT IS THE DEVELOPMENT OF MATERIALS, FUEL, COMPONENT, DIODE, REACTOR, AND SYSTEMS TECHNOLOGY CULMINATING IN THE EVOLUTION OF A TOTAL NUCLEAR THERMIONIC POWERPLANT SYSTEM SUITABLE FOR SPACECRAFT APPLICATIONS FOR ELECTRIC PROPULSION AND/OR AUXILIARY POWER REQUIREMENTS. AEC HAS PRIMARY RESPONSIBILITY FOR THE DEVELOPMENT OF THERMIONIC REACTORS. NASA HAS PRIMARY RESPONSIBILITY FOR THE DEVELOPMENT OF THE ENTIRE NON-NUCLEAR PORTION OF OVER-ALL POWERPLANTS. THIS INCLUDES HEAT REJECTION SYSTEMS, POWER CONDITIONING, PLANT CONTROLS, SHIELDING AND STRUCTURE. IN ADDITION, NASA CONTRIBUTES TO CRITICAL REACTOR TECHNOLOGY SUPPORT IN SELECTED KEY AREAS INCLUDING NUCLEAR FUELS, INSULATOR BREAKDOWN, DIODE TECHNOLOGY, REACTOR CONTROL, MATERIALS, AND SPECIFIC REACTOR CONCEPTS. TASKS ARE ACCOMPLISHED BY A COMBINATION OF IN-HOUSE AND INDUSTRY CONTRACTED PROGRAMS AND COORDINATED THROUGH A JOINT NASA/AEC REACTOR AND SYSTEM STUDY GROUP. THE MAJOR MILESTONES REQUIRED TO ACHIEVE TECHNOLOGY READINESS ARE SEVERAL THOUSAND HOURS OPERATION OF BOTH A THERMIONIC REACTOR, COMPOSED OF PROTOTYPICAL FUEL ELEMENTS, AND A NON-NUCLEAR POWER SUBSYSTEM CONTAINING ALL MAJOR PLANT COMPONENTS EXCEPT REACTOR AND LOAD. EXTRAPOLATION OF PERFORMANCE AND DEGRADATION/FAILURE RATES TO FULL LIFETIME REQUIREMENTS SHOULD HAVE RELATIVELY HIGH CONFIDENCE LEVELS IN ORDER TO ACHIEVE THIS TECHNOLOGY READY STATE. A FOCUS TECHNOLOGY APPLICATION FOR AN UNMANNED NUCLEAR ELECTRIC PROPULSION SYSTEM TO ACHIEVE A HALLEY'S COMET RENDEZVOUS IN MID FY'86 IS RECOMMENDED FOR CONSIDERATION.

RTOP NO. 120-27-41 TITLE: RTG SUPPORT FOR DEEP SPACE ADVANCED
SPACECRAFT

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A. TEL. 213-354-6137

TECHNICAL SUMMARY

THIS TASK IS TO DEVELOP THE RTG TECHNOLOGY REQUIRED TO INTEGRATE AN RTG INTO A SPACECRAFT DESIGNED TO EXPLORE THE OUTER PLANETS, AND TO PROVIDE SUPPORTING RESEARCH AND TECHNOLOGY TO NASA CENTERS CONDUCTING NEAR-TERM MISSIONS. THE WORK WILL BE CONDUCTED IN FIVE PARALLEL PROGRAMS INVOLVING BOTH IN-HOUSE AND CONTRACTED EFFORTS. ESSENTIAL TASKS IN THE PROGRAM INCLUDE (1) THE DEVELOPMENT OF A PROTOTYPE RTG POWER SOURCE FOR EVALUATION AND TESTING IN THE OSSA-APPROVED THERMOELECTRIC OUTER PLANET SPACECRAFT (TOPS) PROJECT. THE MAJOR EMPHASIS IN THIS PHASE OF THE PROGRAM WILL BE IN SUPPORTING THE NECESSARY RTG/SPACECRAFT INTEGRATION, AND CONDUCTING RTG OPTIMIZATION AND TRADE STUDIES. THIS PHASE WILL ALSO ACT AS A FOCUS FOR THE OTHER TECHNOLOGY PROGRAMS, (2) A SILICON-GERMANIUM AND HIGH-TEMPERATURE INSULATION TECHNOLOGY PROGRAM, (3) AN IN-DEPTH NUCLEAR RADIATION PROGRAM TO PROVIDE DATA FROM WHICH THE RADIATION SENSITIVITY OF SPACECRAFT SUBSYSTEMS CAN BE DETERMINED, (4) A THERMOELECTRIC GENERATOR EVALUATION AND IMPROVEMENT PROGRAM WHICH WILL PROVIDE EXPERIMENTAL DATA CONCERNING THE PERFORMANCE AND LONG-TERM OPERATIONAL CHARACTERISTICS OF RTG'S AND FIND METHODS OF IMPROVING THE DESIGN, AND (5) AN RTG IMPROVEMENT AND COMPONENT DEVELOPMENT PROGRAM TO SUPPLY SR&T TO NASA CENTERS CONDUCTING NEAR-TERM MISSIONS.

RTOP NO. 120-27-42 TITLE: LIQUID METAL MHD RESEARCH

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THE OBJECTIVE OF THE LIQUID METAL MHD RESEARCH PROGRAM IS TO DETERMINE THE CONCEPTUAL FEASIBILITY OF A POWER CONVERSION SYSTEM WITH NO MOVING PARTS THAT COULD OPERATE IN THE SOURCE-TEMPERATURE RANGE OF 1800-2000 DEGREES F WHERE RADIATOR AREA IS SMALL, YET MATERIALS PROBLEMS ARE MINIMAL. A LIQUID METAL MHD CONVERTER OPERATES BY ACCELERATING 1800-2000 DEGREES F LITHIUM WITH CESIUM VAPOR AND DECELERATING THE LITHIUM TO PRODUCE ELECTRIC POWER IN A MAGNETOHYDRODYNAMIC GENERATOR. AN 1800 DEGREES F CONVERTER IS THE PROGRAM GOAL. THE FY'71 OBJECTIVES ARE: (1) CLOSED-LOOP CONVERSION SYSTEM TESTING WITH N2-NAK TO EVALUATE MHD CONVERTER EFFICIENCY AND OPERATING CHARACTERISTICS, (2) EROSION AND NOZZLE PERFORMANCE MEASUREMENTS WITH 1800 DEGREES F CS-LI, (3) N2-H2O TESTS OF ADVANCED COMPONENT DESIGNS, (4) INSTALLATION OF ADDITIONAL COMPONENTS OF A 5MW TEST FACILITY FOR 1800 DEGREES F SYSTEM TESTING, AND (5) DESIGN OF AN 1800 DEGREES F CONVERTER. THE APPLICATION OF LIQUID-METAL MHD POWER CONVERSION WOULD BE IN NUCLEAR-ELECTRIC PROPULSION OR SPACE STATION POWER GENERATION ABOVE 100 KWE.

RTOP NO. 120-33-10 TITLE: SOLAR CELL TECHNOLOGY FOR EARTH ORBITAL
SPACE SCIENCE & APPLICATIONS SATELLITES

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: CHERRY, W. R. TEL. 301-982-5845

TECHNICAL SUMMARY

MAJOR EMPHASIS OF THE PROGRAM IS TO DEVELOP MORE EFFICIENT, MORE STABLE, LONGER LIFE AND HIGHLY RELIABLE SPACECRAFT SOLAR POWER SYSTEMS. IMPROVEMENTS IN SOLAR CELLS TO MAKE THEM USEFUL OVER WIDER RANGES OF TEMPERATURE CYCLING, MORE RESISTANT TO ULTRAVIOLET AND ENERGETIC PARTICLE IRRADIATION, AND TO DELIVER MORE WATTS PER POUND OF ARRAY ARE BEING SOUGHT. POWER SYSTEMS STUDIES ARE ENDEAVORING TO DETERMINE THE OPTIMUM OPERATING VOLTAGE RANGES OF A PARTICULAR SPACECRAFT SO AS TO OPTIMIZE THE POWER SUBSYSTEM DESIGN. A SOLAR ARRAY SIMULATOR IS BEING DEVELOPED SO AS TO ENABLE THE EVALUATION OF A SPACECRAFT POWER SYSTEM ON THE GROUND PRIOR TO FLIGHT. COMPUTER PROGRAMS TO BE USED AS DESIGN EVALUATION TOOLS ARE BEING GENERATED. THEY ARE NECESSARY TO CONTRAST THE NUMEROUS VARIABLES TO BE CONSIDERED WHEN OPTIMIZING DESIGNS FOR A PARTICULAR MISSION.

RTOP NO. 120-33-11 TITLE: SOLAR CELLS AND HIGH VOLTAGE
SELF-REGULATING ARRAY TECHNOLOGY

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: BERNATOWICZ, D. T. TEL. 216-433-4000

TECHNICAL SUMMARY

A. RESEARCH AND DEVELOPMENT WILL BE CONDUCTED ON SOLAR POWER SYSTEMS FOR SPACE APPLICATIONS. THE THIN FILM SOLAR CELL PROGRAM WILL BE CONCENTRATED ON THE PRESENT PROBLEMS OF CELL EFFICIENCY, DEGRADATION, AND REPRODUCIBILITY. EVALUATION OF THE CELLS WILL BE MADE IN SIMULATED EARTH ORBIT ENVIRONMENTS. RESEARCH INTO IMPROVEMENTS ON SILICON SOLAR CELLS AND A SEARCH FOR NEW SOLAR CELLS AND DIRECT ENERGY CONVERSION DEVICES WILL CONTINUE. B. RESEARCH AND DEVELOPMENT EFFORT IN TWO MAJOR AREAS IS BEING CONDUCTED ON ADVANCED SOLAR ARRAY POWER SYSTEMS WHICH HOLD CONSIDERABLE PROMISE RELATIVE TO REDUCING POWER SYSTEM COST, COMPLEXITY AND WEIGHT. ONE EFFORT RELATES TO DEFINING ANALYTICALLY AND EXPERIMENTALLY THE MEASURES NECESSARY TO DEVELOP POWER AT KILOVOLT LEVELS ON THE SOLAR ARRAY FOR LOADS SUCH AS ELECTRIC THRUSTORS AND RADIO FREQUENCY POWER AMPLIFIERS. THE OTHER EFFORT RELATES TO DEFINING ANALYTICALLY AND EXPERIMENTALLY POWER CONDITIONING AND SWITCHING SYSTEMS THAT CAN BE MADE AN INTEGRAL PART OF THE SOLAR ARRAY.

RTOP NO. 120-33-12 TITLE: ADVANCED SOLAR POWER STRUCTURES AND
RECHARGEABLE BATTERY CELLS FOR MANNED
SPACE STATIONS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

OBJECTIVE - IN SOLAR ARRAY STRUCTURES THE OBJECTIVE IS TO DEVELOP METHODOLOGY FOR RAPIDLY COMPUTING THE STRUCTURAL DESIGN REQUIREMENTS FOR ANY TYPE OF SOLAR ARRAY (WHETHER ROLL-OUT OR

FOLD-OUT) ON ANY DESIGN OF SPACE STATION OR SPACE BASE. THIS METHODOLOGY MUST TAKE INTO ACCOUNT THE DYNAMIC INTERACTIONS BETWEEN THE SPACECRAFT UNDER ITS CONTROL AND GUIDANCE FORCES WITH THE SOLAR ARRAY COMPLEX IN ITS VARIOUS POSITIONS. THE ULTIMATE END PRODUCT SHOULD BE THE OPTIMUM STRUCTURAL DESIGN OF SOLAR ARRAYS AS NEEDED FOR ANY SPACE STATION OR SPACE BASE WITH ALL IMPORTANT INPUTS AND CONSTRAINTS HANDLED IN A RATIONAL MANNER. THE OBJECTIVE OF THE BATTERY CELL DEVELOPMENT EFFORT IS TO DEVELOP THE TECHNOLOGY REQUIRED OF A RELIABLE LONG LIVED NICKEL-CADMIUM BATTERY FOR SPACE STATION APPLICATION. BATTERY CELLS OF 100 AMPERE HOURS CAPACITY AND LARGER THAT HAVE UNIFORM CURRENT AND TEMPERATURE DISTRIBUTIONS IN THE PLATES WILL BE DEVELOPED. THE APPLICATION OF HEAT PIPES FOR HEAT REMOVAL WILL BE INVESTIGATED. LIFE CYCLING OF DEVELOPED DESIGNS WILL BE CONDUCTED. THIS WORK SHOULD RESULT IN ESTABLISHING AN IMPROVED BATTERY CELL DESIGN AND AID IN SIMPLIFYING THE PROBLEM OF LARGE CAPACITY BATTERY DESIGNS.

RTOP NO. 120-33-13 TITLE: PLANETARY SOLAR ARRAYS AND SOLAR CELL TECHNOLOGY

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THIS EFFORT WILL CONTINUE THE DEVELOPMENT OF SOLAR ARRAY POWER SOURCE TECHNOLOGY FOR PLANETARY SPACECRAFT APPLICATION. PROGRAMS DURING FY 71 WILL INVOLVE INVESTIGATION OF SOLAR CELL ELECTRICAL/MECHANICAL PERFORMANCE UNDER SIMULATED DEEP SPACE CONDITIONS. EVALUATION OF CELLS UNDER MEANINGFUL SIMULATED ENVIRONMENTAL SPACE CONDITIONS REQUIRES SPECIAL TEST FACILITIES AND TECHNIQUES DEVELOPED OVER THE PAST YEARS. EXISTING OPERATIONAL TEST FACILITIES WILL PERMIT EVALUATION OF SOLAR CELLS FROM .01 TO 6.0 EQUIVALENT SOLAR INTENSITIES. EFFORTS WILL ALSO BE EXPENDED IN EVALUATING NEW, DEVELOPMENTAL CONFIGURATIONS OF CELLS MOST NOTEWORTHY OF WHICH ARE THE BARRIER CONTACT AND IMPROVED WRAP-AROUND SOLAR CELLS. ALSO CONTINUED IN FY 71 WILL BE THE INVESTIGATION OF TECHNIQUES TO REDUCE THE COST OF SOLAR PANEL FABRICATION, THE EVALUATION OF ARRAYS AS A POWER SOURCE ON ELECTRIC PROPELLED MISSIONS, AND THE HIGH-ALTITUDE CALIBRATION OF SOLAR CELLS FOR NASA. COST REDUCTION INVESTIGATIONS ARE DESIRED BECAUSE OF THE LARGE EXPENSE REQUIRED FOR SOLAR ARRAYS. THIS EXPENSE FACTOR BECOMES ESPECIALLY SIGNIFICANT AS THE POWER OUTPUT REQUIREMENTS INCREASE. A LARGE SOLAR ARRAY IN 1969 WAS 100 SQ. FT. THERE ARE ANTICIPATED ARRAYS IN THE 1970'S WHICH MAY REQUIRE IN EXCESS OF 5000 SQ. FT. SOLAR ARRAYS FOR ELECTRIC PROPULSION SPACECRAFT UNDER STUDY ARE NECESSARY BECAUSE OF SOME OF THE SPECIAL ENVIRONMENTS OR MODES OF OPERATION THAT MAY BE REQUIRED. OF PARTICULAR INTEREST IS THE INVESTIGATION OF HIGH-VOLTAGE ARRAYS. HIGH-VOLTAGE OPERATION WILL PERMIT SOME SIGNIFICANT WEIGHT SAVING IN ARRAY WIRING WEIGHT, HOWEVER, LITTLE IS KNOWN OF THE DESIGN, FABRICATION AND OPERATION OF THIS KIND OF SOLAR PANEL. HIGH-ALTITUDE-CALIBRATED CELLS ARE REQUIRED FOR MEASURING SOLAR CELLS/ARRAYS ON EARTH. SOLAR CELLS ARE SENSITIVE ONLY TO WAVE-LENGTHS BETWEEN .4 AND 1.1 MICRONS, AND SUNLIGHT FROM SPACE IS MODIFIED SIGNIFICANTLY BY THE SCATTERING AND

ABSORPTION OF AIR AND WATER VAPOR.

RTOP NO. 120-33-14 TITLE: SPACE RADIATION DAMAGE TO SOLAR CELLS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

PARTICULATE RADIATION EFFECTS ON SOLAR CELLS REPRESENT THE SINGLE MOST DAMAGING ENVIRONMENT ENCOUNTERED BY PHOTOVOLTAIC POWER DEVICES IN SPACE. IT IS THE OBJECTIVE OF THIS RTOP TO STUDY THE EFFECTS OF RADIATION ON THE SOLAR CELL STRUCTURE, TO DEVELOP MEANINGFUL MODELS TO DESCRIBE THE OPERATION OF THE CELL AND THE INFLUENCE OF RADIATION, AND TO INVESTIGATE THE DEVELOPMENT OF IMPROVED OR RADIATION HARDENED SOLAR CELLS, PARTICULARLY LITHIUM DIFFUSED CELLS. THESE OBJECTIVES ARE TO BE OBTAINED THROUGH INVOLVEMENT OF ORGANIZATIONS WHICH ARE RECOGNIZED LEADERS IN THE FIELDS OF RADIATION EFFECTS IN PHOTOVOLTAIC CONVERTERS, RADIATION EFFECTS IN SEMICONDUCTORS, SOLID STATE PHYSICS, AND PHOTOVOLTAIC DEVICE DEVELOPMENT. CONTRACTS WILL BE AWARDED TO HIGHLY COMPETENT LABORATORIES ASSOCIATED WITH BOTH INDUSTRIAL ORGANIZATIONS AND EDUCATIONAL INSTITUTIONS. THIS INTERDISCIPLINARY INTERACTION IS REQUIRED BECAUSE OF THE SCOPE AND DEPTH OF THE EFFORT NEEDED TO DEVELOP A SOLAR CELL FOR SPACE APPLICATION. AN UNDERSTANDING OF THE EFFECTS OF IRRADIATION ON THE BASIC PHYSICAL MAKE UP OF SOLAR PHOTOVOLTAIC DEVICES IS OF GREAT IMPORTANCE AS IS THE ABILITY TO PREDICT RELIABLY THE PERFORMANCE OF THE DEVICES AND TO HAVE DEVELOPED FEASIBLE AND PRACTICAL FABRICATION TECHNIQUES. APPROACHING THE IMPROVEMENT OF SOLAR CELL DESIGN, WITHOUT AN UNDERSTANDING OF THE BASIC UNDERLYING PHYSICAL MECHANISMS AND FABRICATION LIMITATIONS CAN BE COSTLY AND UPRODUCTIVE. ONE MAJOR GOAL OF THIS PROGRAM IS THE DEVELOPMENT OF LITHIUM-DIFFUSED SOLAR CELLS TO MISSION READINESS BY 1973.

RTOP NO. 120-33-15 TITLE: EFFECT OF INTERPLANETARY ENVIRONMENT ON SOLAR CELLS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: FOSTER, J. V. TEL. 415-961-1111

TECHNICAL SUMMARY

STUDIES OF THE SILICON H/P SOLAR CELL OPERATING CHARACTERISTICS AND THE INFLUENCE OF THE SPACE RADIATION ENVIRONMENT ON THEIR PERFORMANCE ARE BEING PERFORMED FOR INTERPLANETARY MISSIONS. PREVIOUS STUDIES CONCENTRATED ON ELEVATED TEMPERATURES AND HIGH INTENSITIES; PRESENT WORK EMPHASIZES LOW TEMPERATURES AND LOW INTENSITIES ENCOUNTERED ON A JUPITER TYPE MISSION. A COMPREHENSIVE COMPUTER PROGRAM, VERSATILE SOLAR SIMULATORS, TEMPERATURE CONTROLLED VACUUM IRRADIATION FACILITIES AND INSTRUMENTATION FOR COMPLETE ELECTRICAL AND OPTICAL CHARACTERIZATION OF PROPERTIES AND ELECTRICAL PERFORMANCE HAS BEEN ASSEMBLED. CONTACT HAS BEEN ESTABLISHED WITH EXPERTS AT OTHER NASA CENTERS TO HELP DETERMINE CELL AND COVERGLASS PARAMETERS AND TO DERIVE ANALYTICAL RELATIONSHIPS REQUIRED FOR THE DEVELOPMENT AND EVALUATION OF PHOTOVOLTAIC SYSTEMS FOR INTERPLANETARY

MISSIONS.

RTOP NO. 120-34-02 TITLE: AUXILIARY POWER UNIT (APU) FOR SPACE SHUTTLE

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: BEREMAND, D. G. TEL. 216-433-4000

TECHNICAL SUMMARY

AUXILIARY POWER UNITS (APU) CONSISTING OF TURBINE DRIVEN HYDRAULIC PUMPS AND ALTERNATORS ARE REQUIRED TO MEET THE SUBSTANTIAL LOADS IMPOSED BY THE AERODYNAMIC CONTROL SURFACES, ROCKET ENGINE GIMBALLING, JET ENGINE DEPLOYMENT, VALVE ACTUATION, FUEL PUMPING, AND OTHERS NOT YET DEFINITELY IDENTIFIED. A MAJOR CHARACTERISTIC OF THESE LOADS IS THEIR HIGH RATIO OF PEAK-TO-NORMAL POWER LEVEL. THE SHUTTLE PHILOSOPHY OF OPERATIONAL SURVIVAL WITH ONE CRITICAL FAILURE IMPOSES REDUNDANCY OF APU'S; IT APPEARS THAT THE MOST ECONOMICAL METHOD OF PROVIDING REDUNDANT SYSTEMS IS TO PROVIDE FOR APU OPERATION DURING THE ENTIRE MISSION OF THE BOOSTER, AND DURING THE LAUNCH AND REENTRY PHASE OF THE ORBITER. WORK WILL BE DIRECTED TOWARD THE DEFINITION OF APU DUTY REQUIREMENTS, ANALYSIS AND PRELIMINARY SYSTEM DESIGN, DETAIL DESIGN, AND FABRICATION OF KEY COMPONENTS; DESIGN, FABRICATION, AND PERFORMANCE TESTING OF AN APU SYSTEM TO DEMONSTRATE TECHNOLOGY READINESS.

RTOP NO. 120-34-10 TITLE: PLANETARY BATTERIES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THIS TASK CONSISTS OF: (1) THE DEVELOPMENT OF LONG-LIFE PLANETARY BATTERIES; (2) THE DEFINITION AND RESOLUTION OF INTERFACES RELATED TO LONG-LIFE-BATTERY SYSTEM INTEGRATION FOR FUTURE SPACECRAFT SUCH AS THE ADVANCED MARINERS AND OUTER-PLANET SPACECRAFT; AND (3) THE DEVELOPMENT OF THE TECHNOLOGY FOR HEAT-STERILIZABLE BATTERIES. THE ELEMENTS OF THIS TASK WILL BE ACCOMPLISHED BY: (1) INVESTIGATIONS OF THE EFFECTS OF PARTICULAR ENVIRONMENTAL CONDITIONS ON BATTERIES; (2) THE DESIGN OF SUITABLE BATTERY SYSTEMS; (3) THE DEVELOPMENT OF RELIABLE COMPONENTS AND OF METHODS FOR ASSEMBLING AND USING BATTERIES; (4) THE TESTING AND EVALUATION OF COMPONENTS, BATTERIES, AND BATTERY SYSTEMS. THE WORK WILL BE DONE BY CONTRACTS AND BY IN-HOUSE EFFORTS. THESE DEVELOPMENTS ARE DIRECTED TOWARD PROVIDING THE TECHNOLOGIES FOR PLANETARY MISSIONS REQUIRING LONG-LIVED BATTERY SYSTEMS (7 TO 12 YEARS) AND FOR MARS LANDER MISSIONS REQUIRING HEAT-STERILIZABLE BATTERIES, THUS FORMING A PART OF THE PLANETARY FOCUSED TECHNOLOGY PROGRAM.

RTOP NO. 120-34-11 TITLE: SATELLITE BATTERIES
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: HENNIGAN, T. J. TEL. 301-982-5547
TECHNICAL SUMMARY

A. ADVANCE BATTERY MATERIALS DEVELOPMENT B. DEVELOP NEW CELL CONCEPTS C. DEVELOP NEW CELL AND CHARGE CONTROL CONCEPTS D. IMPROVE CELL CHARACTERIZATION METHODS AND CELL FABRICATION PROCESS CONTROL E. MAINTAIN TEST FACILITIES AND PERFORM BATTERY LIFE TESTS AND PERFORM FAILURE ANALYSIS F. INVESTIGATE THERMAL CHARACTERISTICS AND DEVELOP METHOD TO MAINTAIN BATTERY TEMPERATURES AT OPTIMUM LEVELS.

RTOP NO. 120-34-12 TITLE: ELECTROCHEMICAL POWER DEVICES
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SCHWARTZ, H. J. TEL. 216-433-6910
TECHNICAL SUMMARY

ELECTROCHEMICAL POWER DEVICES HAVE BEEN USED ON VIRTUALLY EVERY LAUNCH VEHICLE AND SPACECRAFT FLOWN TO DATE, AND WILL CONTINUE TO BE USED FOR THE FORESEEABLE FUTURE. THE BROAD SPECTRUM OF MISSION POWER REQUIREMENTS ALREADY KNOWN AND ANTICIPATED DICTATE DEVELOPMENT OF A VARIETY OF ELECTROCHEMICAL POWER SOURCES TO MEET THESE NEEDS. MAJOR EMPHASIS WILL BE PLACED ON AREAS DEALING WITH ADVANCES IN CURRENT BATTERY TECHNOLOGY, HIGH ENERGY SYSTEMS, AND SOLID IONIC CONDUCTORS. THE ALKALINE BATTERY TECHNOLOGY WORK SEEKS IMPROVEMENTS IN CONVENTIONAL BATTERIES, SPECIFICALLY IMPROVED CADMIUM AND SILVER ELECTRODES, LONG-LIFE SILVER-CADMIUM CELLS, AND SILVER-ZINC CELLS CAPABLE OF OPERATION AFTER HEAT-STERILIZATION AND LONG WET-STAND.

RTOP NO. 120-34-20 TITLE: BATTERIES AND FUEL CELLS FOR THE SPACE SHUTTLE
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SCHWARTZ, H. J. TEL. 216-433-4000
TECHNICAL SUMMARY

IT IS ANTICIPATED THAT THE MAIN SOURCE OF ON-BOARD POWER FOR THE SPACE SHUTTLE BOOSTER WILL BE A MEDIUM-RATE BATTERY. IN ADDITION, PEAK LOADS FOR BOTH THE BOOSTER AND ORBITER VEHICLES REQUIRE A BATTERY. THE TECHNOLOGY NEEDED TO CONSTRUCT PRIMARY SILVER-ZINC BATTERIES FOR THESE PURPOSES ALREADY EXISTS. HOWEVER, PRIMARY SILVER BATTERIES APPEAR TOO EXPENSIVE TO MAKE REPLACEMENT AFTER EACH FLIGHT DESIRABLE. THEREFORE, TECHNOLOGY WORK TOWARD DEVELOPING A SILVER-ZINC SECONDARY BATTERY CAPABLE OF CYCLIC OPERATION COUPLED WITH VERY LONG WET-STAND IS REQUIRED. THE PROJECTED POWER REQUIREMENTS FOR THE ORBITER STAGE OF THE SPACE SHUTTLE APPEAR TO BE IDEALLY SUITED FOR USE OF A HYDROGEN-OXYGEN FUEL CELL. THE LOW TEMPERATURE, ALKALINE, MATRIX-TYPE CELL IS THE PREFERRED CHOICE. WHILE EXISTING TECHNOLOGY WILL PERMIT CONSTRUCTION OF A SYSTEM SUITABLE FOR ONE OR SEVERAL SHUTTLE FLIGHTS, A MAJOR IMPROVEMENT IN FUEL CELL AND SYSTEM LIFE IS DESIRED. A COMBINED IN-HOUSE AND CONTRACTUAL PROGRAM WILL BE UNDERTAKEN LEADING TOWARD A FUEL CELL SYSTEM OFFERING SUBSTANTIAL IMPROVEMENTS IN LIFE, SPECIFIC WEIGHT AND OPERATING FLEXIBILITY AS COMPARED TO PRESENT-DAY SYSTEMS. THIS WORK

WILL BE COORDINATED WITH THE SPACE SHUTTLE FUEL CELL TECHNOLOGY EFFORT AT MSC.

RTOP NO. 120-60-01 TITLE: POWER PROCESSING RESEARCH & ADVANCED
DEVELOPMENT FOR ELECTRIC PROPULSION
SYSTEMS

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: SCHWARZ, F. C. TEL. 216-433-4000

TECHNICAL SUMMARY

OBJECTIVES: ESTABLISH TECHNOLOGY FOR SINGLE-MODULE
MULTIKILOWATT ELECTRIC POWER DC CONVERTERS WHICH CAN BE CLUSTERED TO
ATTAIN POWER LEVELS OF TENS AND HUNDREDS OF KILOWATTS; TO PROVIDE
THESE CONVERTERS WITH THE NEEDED MEANS OF CONTROL INCLUDING MAXIMUM
POWER TRACKING AND ACCURACY OF DESIGN PERFORMANCE; TO MAXIMIZE
RELIABILITY AND EFFICIENCY OF OPERATION AND TO MINIMIZE PHYSICAL
WEIGHT AND SIZE.

RTOP NO. 120-60-02 TITLE: AIRCRAFT ELECTRICAL POWER SYSTEM
TECHNOLOGY

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: SCHWARZ, F. C. TEL. 216-433-4000

TECHNICAL SUMMARY

OBJECTIVES: ESTABLISH IMPROVED AIRCRAFT ELECTRIC SYSTEMS
TECHNOLOGY (1) WITH A SUBSTANTIAL INCREASE IN RELIABILITY FOR REDUCED
MAINTENANCE OF FLIGHT AND SUPPORTING GROUND BASED EQUIPMENT, (2) WITH
A SIGNIFICANT IMPROVEMENT OF THE KW/KG RATIO OF THE OVERALL ELECTRIC
SYSTEM FOR INCREASED PHYSICAL WEIGHT OF PAYLOAD VS FLIGHT EQUIPMENT
IN AIRCRAFT.

RTOP NO. 120-60-04 TITLE: ELECTRICAL POWER PROCESSING AND
DISTRIBUTION FOR PLANETARY SPACECRAFT

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THIS TASK PROVIDES FOR THE DEVELOPMENT OF POWER PROCESSING,
POWER DISTRIBUTION, AND RELATED POWER SYSTEM CONFIGURATION AND
INTEGRATION TECHNOLOGY FOR FUTURE PLANETARY SPACECRAFT. IT DEVELOPS
THE NECESSARY CAPABILITY, TECHNIQUES, AND HARDWARE REQUIRED TO
PRODUCE HIGH-RELIABILITY POWER SYSTEMS FOR ADVANCED "MARINER-TYPE"
AND OUTER-PLANET MISSIONS. THE PRESENT POWER PROCESSING AND
DISTRIBUTION SYSTEM TECHNOLOGY WHICH IS AVAILABLE AND HAS BEEN
DEMONSTRATED IS GROSSLY INADEQUATE FOR MANY FUTURE MISSIONS. IN
PARTICULAR, MISSIONS SUCH AS THE GRAND TOUR, WHICH REQUIRES 12 YEARS
LIFE, A SPECIFIC WEIGHT OF 50 LBS/KW OR LESS, AND IMMUNITY FROM
SINGLE PIECE-PART FAILURE, CANNOT BE CARRIED OUT WITH TODAY'S
TECHNOLOGY. THE WORK TO BE DONE INCLUDES: (1) THE DEVELOPMENT OF AN
ENGINEERING MODEL POWER PROCESSING AND DISTRIBUTION SYSTEM FOR
EVALUATION AND TESTING IN THE THERMOELECTRIC OUTER PLANET SPACECRAFT

(TOPS) PROJECT, (2) THE DEVELOPMENT OF NEW TECHNOLOGY PROTOTYPE OR BREADBOARD POWER PROCESSING ELEMENTS FOR ADVANCED "MARINER-TYPE" SPACECRAFT. THE PURPOSE OF THIS WORK IS TO DEMONSTRATE THE APPLICABILITY OF NEW TECHNOLOGY EMERGING FROM INDUSTRY AND NASA CENTERS TO FUTURE MISSIONS. THE WORK WILL BE CARRIED ONLY FAR ENOUGH TO PROVIDE ADEQUATE JUSTIFICATION TO FUTURE PROJECTS THAT THE TECHNOLOGY IS "FLIGHT READY" AND IS CAPABLE OF BEING ADAPTED TO TYPICAL "MARINER-TYPE" PLANETARY SPACECRAFT REQUIREMENTS.

RTOP NO. 120-60-06 TITLE: POWER PROCESSING AND DISTRIBUTION
TECHNOLOGY FOR EARTH ORBITAL SPACE
SCIENCE AND APPLICATIONS SATELLITES

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: CHERRY, W. R. TEL. 301-982-5845

TECHNICAL SUMMARY

POWER CONDITIONING DEVELOPMENTS ARE SEEKING TO INCREASE CONVERSION EFFICIENCIES, UTILIZE VERY LOW INPUT VOLTAGES EFFECTIVELY, AND TRANSFER POWER FROM A STATIONARY OR ORIENTED PLATFORM, SUCH AS A SOLAR ARRAY OR ANTENNA, TO A SPINNING VEHICLE. INVESTIGATIONS OF THICK FILM INTEGRATED CIRCUITS AND THE UTILIZATION OF FERROMAGNETIC AND AIR CORE TRANSFORMERS SO AS TO REDUCE WEIGHT AND SIZE OF POWER CONDITIONING SUBSYSTEMS IS PROPOSED.

RTOP NO. 120-60-10 TITLE: SPACE SHUTTLE ELECTRICAL POWER PROCESSING
AND DISTRIBUTION TECHNOLOGY

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: SCHWARZ, F. C. TEL. 216-433-4000

TECHNICAL SUMMARY

OBJECTIVES: ESTABLISH TECHNICAL CRITERIA FOR CONCURRENT OPTIMIZATION OF ELECTRIC POWER SOURCES, DISTRIBUTION, CONVERSION AND UTILIZATION TECHNOLOGY FOR DESIGN OF POWER SYSTEMS AND THEIR SUBSYSTEMS OF REUSEABLE LARGER HYBRID AIR AND SPACEBORNE CRAFT, REQUIRING POWER CAPACITIES IN THE ORDER OF TENS OF KW IN SPACE AND HUNDREDS OF KVA WHEN AIRBORNE, AND WITH DUE CONSIDERATION OF THE POWER SYSTEMS TRANSITION PHASE DURING REENTRY INTO THE ATMOSPHERE.

RTOP NO. 120-60-13 TITLE: PYROTECHNIC POWER AND CONTROL

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

(A) TECHNOLOGY WORK, BOTH ANALYTICAL AND EXPERIMENTAL, WILL BE PERFORMED TO ADVANCE THE STATE-OF-THE-ART IN POWER AND CONTROL TECHNIQUES FOR THE ACTUATION OF ELECTROMECHANICAL AND ELECTRO EXPLOSIVE DEVICES. (B) THE APPROACHES WILL BE TO EVALUATE VARIOUS NEW ENERGY SOURCES SUCH AS SOLID STATE ELECTROCHEMICAL CELLS AND ELECTRONIC COMPONENTS; DEVISE AND OPTIMIZE CIRCUIT AND PACKAGING CONFIGURATIONS; DEMONSTRATE RESULTANT CONCEPTS IN BREADBOARD UNITS. (C) IMPROVEMENTS IN THE TECHNOLOGY FOR DELIVERING, CONDITIONING,

STORAGE, PULSE SHAPING, AND SWITCHING OF ELECTRICAL POWER AND FOR INTERNAL SUBSEQUENCING LOGIC TO ACTUATE ELECTRO-MECHANICAL AND ELECTRO-EXPLOSIVE DEVICES ARE REQUIRED FOR FUTURE SPACECRAFT UNDER CONDITIONS OF LONG LIFE AND/OR LIMITED VOLUME. ORIGINAL INTENT WAS TO COORDINATE THIS RTOP WITH EXPERTS AT NASA/ERC. NO WORK HAS BEEN DONE BY ERC ALONG THESE LINES. THE PHASE-OUT OF ERC INCREASES THE NEED FOR TIMELY EXECUTION OF THIS TASK.

RTOP NO. 121-30-10 TITLE: NUCLEAR VEHICLE-SPACECRAFT SHIELDING
DESIGN ANALYSIS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G.

TEL. 205-453-1120

TECHNICAL SUMMARY

THE OBJECTIVES OF THE PROGRAM ARE TO FURTHER DEVELOP AND MAINTAIN A SHIELDING DESIGN AND ANALYSIS CAPABILITY AND TO UTILIZE THIS CAPABILITY IN INDEPENDENTLY-CONDUCTED SHIELDING STUDIES FOR APPLICATION TO NUCLEAR STAGE DEVELOPMENT. THE CONCEPT OF NUCLEAR PROPULSION HAS BEEN THOROUGHLY STUDIED, AND THE FEASIBILITY OF WORKABLE SPACE PROPULSION SYSTEMS WELL DEMONSTRATED. MANY PROBLEMS STILL EXIST, HOWEVER, AMONG THE MORE SIGNIFICANT OF WHICH IS THE ADEQUATE ASSESSMENT OF AND PROVISION FOR THE RADIATION ENVIRONMENT. IN ORDER TO PROTECT ADEQUATELY ALL COMPONENTS, SYSTEMS, AND PERSONNEL AGAINST THE DELETERIOUS EFFECTS OF NUCLEAR RADIATION, IT IS NECESSARY TO UTILIZE COMPLEX RADIATION TRANSPORT PROCEDURES TO DETERMINE DOSE RATES AT VARIOUS LOCATIONS AROUND THE REACTOR SHIELD ASSEMBLY AND TO DESIGN SHIELD TO REDUCE ANY EXCESSIVE DOSE RATES TO ACCEPTABLE LEVELS. TO OBTAIN THOSE GOALS, A PROGRAM OF CONTINUING CODE DEVELOPMENT AND REFINEMENT IS UNDERWAY, ALONG WITH A SUSTAINED EFFORT TO COLLECT, UPDATE, EVALUATE, AND PREPARE INPUT DATA FOR USE IN THE AVAILABLE CODES. THE CALCULATION METHODS ARE USED TO OBTAIN OPERATIONAL DOSE RATES, ACTIVATION LEVELS, AND AFTER-SHUTDOWN RADIATION FIELDS FOR TYPICAL NUCLEAR VEHICLE CONFIGURATIONS AND TO AID IN SHIELD DESIGN OPTIMIZATION STUDIES.

RTOP NO. 121-30-15 TITLE: TELEOPERATOR SYSTEMS DEVELOPMENT

ORGANIZATION: SPACE NUCLEAR PROPULSION OFFICE

MONITOR: JOHNSON, E. G.

TEL. 301-973-3353

TECHNICAL SUMMARY

THERE HAVE BEEN TECHNOLOGY INVESTIGATIONS OF TELEOPERATOR COMPONENTS AND SYSTEMS FUNDED AND DIRECTED BY SNPO OVER THE PAST 10 YEARS. THESE MODESTLY HAVE DEALT WITH THE FOLLOWING: 1) AN IN-HOUSE PROJECT WAS RECENTLY COMPLETED, COVERING THE DESIGN, FABRICATION, AND TEST OF A TELEOPERATOR SYSTEM MOUNTED ON A MOTORIZED VEHICLE, AND REMOTELY CONTROLLED FROM A CENTRAL STATION BY MEANS OF A RADIO LINK. THE COMPLETE SYSTEM INCLUDED TV CAMERA AND RECEIVER, MASTER-SLAVE MANIPULATOR, AND RADIO DIRECTED VEHICLE POWER AND DIRECTIONAL CONTROLS. 2) A GRANT TO CASE WESTERN RESERVE TO

INVESTIGATE TECHNIQUES FOR COMPUTER CONTROL OF RATE CONTROLLED MANIPULATORS. 3) THE DESIGN AND DEVELOPMENT OF A HEAD CONTROLLED TV SYSTEM. THE HARDWARE WAS DESIGNED AS A TEST BED IN ORDER TO TRY SEVERAL CONCEPTS. 4) AN IN-HOUSE INVESTIGATION TO DETERMINE IF AMPUTEES COULD BE TRAINED AS MANIPULATOR OPERATORS. 5) DESIGN AND CONSTRUCTION OF SPECIAL EQUIPMENT. SPECIFICALLY A LARGE WALL MOUNTED HANDLING SYSTEM AN ENGINE INSTALLATION VEHICLE. SEVERAL TELEOPERATOR SYMPOSIA HAVE BEEN HELD OVER THE PAST 6 YEARS IN WHICH CURRENT STATUS AND FUTURE DIRECTIONS WERE DISCUSSED. THE MOST RECENT WERE A NUCLEAR SHUTTLE IN-SPACE MAINTAINABILITY SYMPOSIUM HELD DURING FEBRUARY, 1970, AND A TELEOPERATOR CONFERENCE AT MSC DURING MARCH, 1970.

RTOP NO. 121-30-17 TITLE: NUCLEAR STAGE STRUCTURES
ORGANIZATION: SPACE NUCLEAR PROPULSION OFFICE
MONITOR: MILLER, D. J. TEL. 301-973-4547
TECHNICAL SUMMARY

NUCLEAR STAGE DEFINITION PHASE A STUDIES UNDERWAY SINCE JULY 1969 HAVE EVOLVED A SERIES OF CONCEPTS BASED ON USE OF THE SPACE SHUTTLE AS A CARRIER FOR TRANSPORTING NUCLEAR STAGES TO EARTH-ORBIT. SINCE TYPICAL NUCLEAR STAGE MISSIONS REQUIRE 300,000 LB. OF LH2 PROPELLANT, THIS REQUIRES MANY LAUNCHES OF A SHUTTLE TO TRANSPORT MODULAR NUCLEAR STAGE TANKS LIMITED TO DIMENSIONS OF THE SHUTTLE CARGO BAY, I.E., 15 DIA. X 60 LENGTH. ADVANCED STRUCTURAL DESIGN AND ASSEMBLY CONCEPTS ARE REQUIRED TO MINIMIZE THE NUMBER OF SHUTTLE FLIGHTS REQUIRED TO ORBIT THE REQUISITE NUMBER OF MODULES FOR A MISSION. SIMILARLY, THE NUMBER OF RETURN FLIGHTS OF THE SPACE SHUTTLE FOR REFURBISHMENT OF NUCLEAR MODULES ON EARTH MAY BE REDUCED BY PROPER ATTENTION TO STRUCTURAL DESIGN.

RTOP NO. 121-30-18 TITLE: NUCLEAR ROCKET APPLICATION AND TECHNOLOGY
PLANNING STUDIES
ORGANIZATION: SPACE NUCLEAR PROPULSION OFFICE
MONITOR: SCHWENK, F. C. TEL. 301-973-4547
TECHNICAL SUMMARY

STUDIES OF NUCLEAR ROCKET APPLICATIONS HAVE BEEN CONDUCTED DURING THE PAST YEARS TO PROVIDE REQUIREMENTS AND GUIDANCE FOR PLANNING DEVELOPMENT AND TECHNOLOGY PROGRAMS. SOME OF THIS WORK CAN AND IS BEING DONE IN-HOUSE AT MAD AND THE NASA CENTERS. ON OCCASION, IT IS VALUABLE TO CONTRACT FOR STUDIES AS THE NEED REQUIRES TO DEVELOP NEW ANALYTICAL TOOLS, TO INTEGRATE THE NUCLEAR SYSTEMS WITH THE SPACE SYSTEMS, TO EXPLORE THE VALUE OF NEW CONCEPTS AND PERFORMANCE IMPROVEMENTS, AND TO CONSIDER UNIQUE MISSIONS. THIS RTOP COVERS CONTINUATION OF A GRANT WITH PRINCETON UNIVERSITY AND OF THE STUDY ACTIVITY BY THE AEROSPACE CORPORATION IN THE AREA OF REUSABLE NUCLEAR STAGE (RNS) APPLICATIONS. PREVIOUS AEROSPACE STUDIES WERE CONDUCTED UNDER JOINT NASA/USAF FUNDING, WITH PRINCIPAL NASA MANAGEMENT BY OMSF BUT WITH SNPO DIRECTION OF THE RNS TASK. FY 1971 EFFORT BY AEROSPACE, IF CONTRACTED, WILL BE FUNDED BY SNPO.

RTOP NO. 121-30-19 TITLE: REUSABLE NUCLEAR STAGE TECHNOLOGY
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

THE LONG RANGE OBJECTIVES OF EFFORT UNDER THIS RTOP WILL BE DEVELOPMENT OF TECHNOLOGY FOR THE SUPPORT OF CONCEPTUAL DESIGNS OF THE REUSABLE NUCLEAR STAGE IN THE AREAS OF LONG LIVED COMPONENTS AND SYSTEMS CAPABLE OF OPERATION IN A NUCLEAR ENVIRONMENT, WITH THE CAPABILITY FOR THE STAGE TO BE TRANSPORTED IN THE CHEMICAL SPACE SHUTTLE TO EARTH ORBIT WHERE IT WILL HAVE CAPABILITY OF BEING ASSEMBLED, CHECKED OUT, LAUNCHED, MAINTAINED AND REFURBISHED. THE FY'71 OBJECTIVES WILL BE FOLLOW-ON EFFORT IN AREAS OF RADIATION EFFECTS ON MATERIALS, INTEGRATED NEUTRON ACTIVATION PREDICTION CODE, RADIATION EFFECTS MEASURING INSTRUMENTATION, ADVANCED ELECTRONIC STAGE INSTRUMENTATION AND NUCLEAR PROPELLANT HEATING AND STRATIFICATION EXPERIMENT DESIGN FOR APPLICATION TO THE REUSABLE NUCLEAR STAGE. THE STORAGE OF CRYOGENICS ABOARD THE NUCLEAR SHUTTLE AND THE ORBITAL PROPELLANT DEPOT CAN BE INCREASED IN TIME AND MASS BY THE USE OF SOLID/LIQUID MIXTURES COMMONLY CALLED SLUSH. THIS TECHNIQUE IS PARTICULARLY VALUABLE IN THE STORAGE OF LIQUID HYDROGEN AND IT IS THIS AREA THAT TECHNOLOGY DEVELOPMENT WILL PROVIDE SIGNIFICANT PAYOFF IN INCREASED PAYLOADS IN THE AREA OF RESUPPLY OF HYDROGEN FOR THE NUCLEAR SHUTTLE AND THE SPACE STATION AND INTERPLANATARY FLIGHTS OF THE NUCLEAR SHUTTLE. THE INSTRUMENTATION TECHNOLOGY TO BE PURSUED WILL BE IN THE AREAS OF MASS FLOW, LEVEL, DENSITY, TEMPERATURE, NUCLEAR EFFECTS MEASUREMENTS AND VEHICLE INSTRUMENTATION FOR NUCLEAR SHUTTLE. FY'71 NEW START EFFORT WILL INCLUDE PRIMARY STRUCTURES CONCEPTS FOR REUSABLE NUCLEAR STAGE, DEVELOPMENT OF MAINTAINABILITY CRITERIA AND MAINTENANCE/REPAIR TECHNIQUES, AND ASSEMBLY, CHECKOUT, AND OPERATION OF A SLUSH HYDROGEN GENERATION AND HANDLING FACILITY IN-HOUSE AT MSFC.

RTOP NO. 122-05-01 TITLE: FLIGHT SAFETY R&D
ORGANIZATION: SPACE NUCLEAR PROPULSION OFFICE
MONITOR: GAVIGAN, F. X. TEL. 301-973-4335
TECHNICAL SUMMARY

DURING THE NUCLEAR ROCKET TECHNOLOGY PROGRAM, THE NERVA ENGINE WAS INVESTIGATED FROM A SAFETY VIEWPOINT TO ESTABLISH BASIC LIMITS AND ENVELOPES ON CHEMICAL AND PHYSICAL REACTIONS WHICH COULD OCCUR AND TO ESTABLISH PROBABILISTIC ESTIMATES OF DOSE EFFECTS. THE PURPOSE OF THE SAFETY PROGRAM WAS TO IDENTIFY IN A GROSS WAY THE SAFETY ADVANTAGES AND FEATURES OF THE NUCLEAR ROCKET. WITH THE INITIATION OF A DEVELOPMENT PROGRAM ANOTHER TYPE OF SAFETY PROGRAM IS NOW NEEDED TO CONSOLIDATE THE RESULTS OF PAST STUDIES AND TO EMPHASIZE OPERATIONAL ASPECTS OF THE NUCLEAR ROCKET SO THAT SAFETY REQUIREMENTS CAN BE DEVELOPED AND FED INTO THE OVERALL ENGINE AND STAGE DESIGN. STUDIES ARE BEING MADE BY THE STAGE AND ENGINE CONTRACTORS FOR EACH OF THEIR ELEMENTS OF THE NUCLEAR ROCKET PROGRAM. OVERALL STUDIES MUST BE PERFORMED TO LOOK AT NUCLEAR ROCKET

OPERATIONS FROM A BROADER VIEW, AND TO EXAMINE INTERFACES AND TO IDENTIFY UNIQUE NEEDS. THIS IS TO BE CARRIED OUT THROUGH CONTRACTORS WHO HAVE SYSTEMS SAFETY CAPABILITY, EXCEPT WHERE R&D NEEDS ARE IDENTIFIED. IN THE LATTER CASE THE STAGE, ENGINE OR A SPECIALTY CONTRACTOR WILL BE UTILIZED TO OBTAIN DATA. THE APPROACH WILL VARY DEPENDING ON WHETHER A SAFETY LOGIC ANALYSIS TECHNIQUE IS BEING USED OR WHETHER DETAILED R&D INFORMATION IS BEING OBTAINED TO FILL GAPS IN KNOWLEDGE. MOST OF THE WORK WILL BE A CONTINUATION OF PRIOR YEAR CONTRACTS OR GRANTS. ALL OF THE OUTPUT WILL BE USED TO GENERATE ENGINE OR STAGE REQUIREMENTS, TO ESTABLISH CRITERIA, OR TO AID IN ESTABLISHING A FIRM BASE OF KNOWLEDGE TO ASSURE THAT NUCLEAR ROCKETS MAY BE SAFELY FLOWN.

RTOP NO. 122-28-13 TITLE: APPLICATION OF CONTROLLED THERMONUCLEAR FUSION TO PROPULSION

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: RAYLE, W. D. TEL. 216-433-4000

TECHNICAL SUMMARY

THEORETICAL AND EXPERIMENTAL WORK WILL BE CONDUCTED TO DETERMINE THE FEASIBILITY AND THE MAJOR PROBLEM AREAS IN THE APPLICATION OF CONTROLLED FUSION TO SPACE PROPULSION. EMPHASIS WILL BE PLACED ON THOSE PROBLEMS THAT SEEM MOST CRUCIAL TO THE ATTAINMENT OF USEFUL SPECIFIC MASSES. THE ANALYTICAL WORK WILL BE CENTERED ON THE DEUTERIUM-HELIUM-3 REACTION WHICH HAS NO NEUTRONS AS DIRECT PRODUCTS.

THE NECESSARY CONDITIONS FOR NET POWER PRODUCTION FROM THIS REACTION WILL BE SPECIFIED, AND THE IMPLIED FLUXES OF RADIATION AND PARTICLES ESCAPING WILL BE EXAMINED TO DETERMINE THE REQUIREMENTS FOR SHIELDING AND COOLING OF STRUCTURES AND COMPONENTS. PLASMA HEATING AND CONFINEMENT STUDIES WILL BE CARRIED OUT IN MAGNETIC CONFIGURATIONS APPROACHING THE SIZE AND STRENGTHS THAT WILL BE NEEDED IN THE SPACE APPLICATION. THIS INVOLVES SUPERCONDUCTING CONFIGURATIONS BOTH CLOSED AND OPEN WITH FIELD STRENGTHS OF UP TO ABOUT 7 TESLA. WHEN SUFFICIENTLY HOT AND DENSE PLASMAS ARE ATTAINED, THEY WILL BE USED TO STUDY THE TRANSFER OF ENERGY FROM HOT PLASMAS TO COLD PROPELLANT. EFFORT WILL BE MADE TO REDUCE THE MASS OF SUPERCONDUCTORS AND ASSOCIATED CRYOGENIC SYSTEMS.

RTOP NO. 122-28-14 TITLE: ADVANCED NUCLEAR PROPULSION CONCEPTS

ORGANIZATION: SPACE NUCLEAR PROPULSION OFFICE

MONITOR: MILLER, D. J. TEL. 301-973-4547

TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS RESEARCH IS TO INVESTIGATE ADVANCED NUCLEAR PROPULSION CONCEPTS TO DETERMINE WHETHER THEY ARE FEASIBLE IN A USEFUL FORM FOR ROCKET PROPULSION APPLICATIONS. SPECIFICALLY, THE ROTATING FLUIDIZED BED CONCEPT OF DUST BED REACTORS AND THE NUCLEAR LIGHT BULB CONCEPT OF CLOSED CYCLE GASEOUS CORE REACTORS ARE BEING INVESTIGATED; RESEARCH ON OPEN CYCLE GAS CORE SYSTEMS IS BEING CONDUCTED UNDER LERC SPONSORSHIP. THE KEY PROBLEMS OF THE DUST BED CONCEPT HAVE NOT BEEN IDENTIFIED AND THE RESEARCH TO BE SUPPORTED IS DESIGNED TO ESTABLISH AND INVESTIGATE THESE PROBLEMS

ONCE IDENTIFIED. THE KEY PROBLEMS OF THE NUCLEAR LIGHT BULB CONCEPT HAVE BEEN IDENTIFIED AND GENERALLY DEAL WITH (1) THE CAPABILITIES OF THE TRANSPARENT WALL TO SURVIVE IN THE EXPECTED THERMAL AND NUCLEAR ENVIRONMENT, (2) THE CHARACTERIZATION OF THE THERMAL AND SPECTRAL ENVIRONMENT, (3) ESTABLISHING TESTS THAT REALISTICALLY SIMULATE THE ACTUAL ENGINE CONDITIONS, AND (4) ESTABLISHING A STARTUP AND RUN MODE THAT IS COMPATIBLE WITH THE CAPABILITIES OF THE SYSTEM. THE NUCLEAR LIGHT BULB RESEARCH IS PRIMARILY DIRECTED TOWARD THE SOLUTIONS OF THESE PROBLEMS, HOWEVER, THE TOOLS TO CONDUCT SUCH RESEARCH ARE NOT ALWAYS AVAILABLE AND MUCH OF THE EFFORT MUST BE DIRECTED TOWARD DEVELOPING TEST TOOLS.

RTOP NO. 122-28-20 TITLE: FEASIBILITY OF GAS-CORE REACTORS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ROM, F. E. TEL. 216-433-4000
TECHNICAL SUMMARY

RESEARCH WILL BE CONDUCTED IN THE AREA OF ADVANCED NUCLEAR PROPULSION ON GAS-CORE REACTORS. 1. DO HOT FLOW STUDIES THAT SIMULATE TO AN INCREASING DEGREE THE FLOW SITUATION THAT WOULD EXIST IN A NUCLEAR ENGINE. 2. DO LARGE-SCALE, COLD-FLOW EXPERIMENTS TO DETERMINE SCALING LAWS NECESSARY TO RELATE OBSERVATIONS FROM LABORATORY STUDIES TO A FULL SIZE ENGINE. 3. DO NUCLEAR CRITICAL EXPERIMENTS TO PROVIDE BASE POINTS FROM WHICH PREDICTIONS OF ENGINE CRITICAL MASS CAN BE MADE FOR THE NEW GAS-CORE CONFIGURATIONS THAT RESULT FROM THE NEW FLOW STUDIES, TO ALLOW ENGINE CONFIGURATION AND FUEL SELECTIONS THAT WILL MINIMIZE THE CRITICAL MASS, AND TO FURNISH DATA FOR STABILITY, DYNAMICS AND CONTROLLABILITY DETERMINATIONS.

RTOP NO. 122-29-13 TITLE: COMPONENT AND GENERAL SUPPORTING TECHNOLOGY
ORGANIZATION: SPACE NUCLEAR PROPULSION OFFICE
MONITOR: GAVIGAN, F. X. TEL. 301-973-4335
TECHNICAL SUMMARY

THE SPACE NUCLEAR PROPULSION OFFICE HAS CONDUCTED COMPONENT R&D TO SUPPORT REACTOR TESTS, TO PROVIDE TECHNOLOGY FOR NERVA, TO EXPLORE ADVANCED TECHNIQUES AND TO PROVIDE BASIC DESIGN AND MATERIALS DATA. THIS WORK WILL CONTINUE, BUT PRIMARILY IN AREAS OF ADVANCED COMPONENTS, TECHNIQUES, AND DATA REQUIREMENTS.

RTOP NO. 122-29-14 TITLE: HYDROGEN PROPERTIES EVALUATION, HANDLING TECHNIQUES, AND STAGE TANKAGE
ORGANIZATION: SPACE NUCLEAR PROPULSION OFFICE
MONITOR: MILLER, D. J. TEL. 301-973-4547
TECHNICAL SUMMARY

EXTENSIVE TECHNOLOGY INVESTIGATIONS SPANNING A TIME PERIOD PARALLEL TO THAT OF THE NERVA PROJECT HAVE PROVIDED VALUABLE DATA IN THE AREA OF HYDROGEN PROPERTIES AND CRYOGENIC INSTRUMENTATION. AS THE DEPTH OF KNOWLEDGE HAS INCREASED, MORE ADVANCED INVESTIGATIONS

HAVE BEEN CONDUCTED. PRESENTLY EMPHASIS HAS BEEN PLACED ON MANUFACTURE AND CHARACTERIZATION OF "SLUSH" HYDROGEN, I.E., MIXTURES OF LIQUID/SOLID HYDROGEN IN VARIOUS RATIOS. PARALLELING THIS EFFORT HAS BEEN SUPPORTING ACTIVITY ON PROVIDING SPECIALIZED MEASURING INSTRUMENTATION SUITABLE FOR DETERMINING SLUSH SOLID/LIQUID RATIOS IN A CLOSED STORAGE TANK IN O-G ENVIRONMENT. PLANS FOR THE NEAR FUTURE CALL FOR EXTENDING THE SLUSH HYDROGEN WORK TO INCLUDE FORMATION OF HYDROGEN GELS, AND COMBINATIONS OF SLUSH/GELS, AND FOR INVESTIGATING NOVEL IDEAS FOR TANKAGE SYSTEMS COMPATIBLE WITH PROSPECTIVE LAUNCH VEHICLES. ALL OF THIS ACTIVITY IS AIMED PRIMARILY AT MINIMIZING HYDROGEN BOIL-OFF DURING EXTENDED PERIODS OF STORAGE AND PROVIDING OPTIMUM TANKAGE FOR NUCLEAR STAGES.

RTOP NO. 122-29-20 TITLE: IMPROVED COMPONENTS AND MATERIALS FOR
SOLID CORE NUCLEAR ROCKET ENGINES

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: BARILE, S. TEL. 216-433-6271

TECHNICAL SUMMARY

IN ORDER TO PROVIDE BASIC TECHNOLOGY FOR IMPROVED COMPONENTS FOR NUCLEAR ROCKET ENGINES, RESEARCH WILL BE CONDUCTED IN THE FOLLOWING AREAS: (1.) IRRADIATION EFFECTS ON SOLID LUBRICANTS; (2.) IRRADIATION EFFECTS ON THE TENSILE STRENGTH AND THE LOW-CYCLE FATIGUE LIFE OF VARIOUS MATERIALS; (3.) ROCKET NOZZLE COATINGS AND HEAT TRANSFER; (4.) HYDROGEN COOLED BEARING RESEARCH BEING CONDUCTED UNDER RTOP 129-03-24.

RTOP NO. 124-07-13 TITLE: AEROTHERMODYNAMICS AND ABLATIVE HEAT
PROTECTION FOR VERY HIGH SPEED
ATMOSPHERIC ENTRY

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH ARE TO DEVELOP TECHNIQUES AND APPARATUS FOR TESTING HEAT-SHIELD MATERIALS IN HIGH ENTHALPY AND HIGH-RADIATIVE HEATING ENVIRONMENTS ASSOCIATED WITH VERY HIGH SPEED ATMOSPHERIC ENTRIES AND TO DETERMINE THE RESPONSE OF HEAT-SHIELD MATERIALS TO SUCH CONDITIONS. AN ADDITIONAL OBJECTIVE IS TO OBTAIN A BETTER UNDERSTANDING OF THE EFFECT OF LONG TERM SPACE EXPOSURE ON THE PERFORMANCE OF ABLATION MATERIALS. THE RESEARCH WILL CONSIST OF INVESTIGATION OF MATERIAL RESPONSE BY ANALYTICAL STUDIES CONDUCTED IN-HOUSE AND ON A GRANT. IN ADDITION, EXPERIMENTAL EVALUATION OF MATERIAL RESPONSE TO HIGH RADIATIVE HEATING RATES WILL BE PERFORMED BY CONDUCTING CONTRACT TESTING. IN-HOUSE DESIGN STUDIES OF MEANS OF PRODUCING HIGH-ENTHALPY TEST STREAMS AND COMBINED RADIATIVE-CONVECTIVE HEATING TEST ENVIRONMENTS WILL BE CONDUCTED WITH EQUIPMENT FABRICATION BEING DONE ON CONTRACT. IN-HOUSE EXPERIMENTAL STUDIES WILL BE CONDUCTED TO DETERMINE THE EFFECT OF SPACE EXPOSURE

ON ABLATIVE MATERIAL PERFORMANCE DURING ENTRY.

RTOP NO. 124-07-13 TITLE: AEROTHERMODYNAMIC AND ABLATIVE HEAT
PROTECTION FOR VERY-HIGH-SPEED
ATMOSPHERIC ENTRY

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DEVELOP THE AEROTHERMODYNAMIC AND ABLATIVE HEAT-PROTECTION TECHNOLOGY REQUIRED TO DESIGN UNMANNED SPACECRAFT FOR ENTRY INTO VENUS AND THE OUTER PLANETS, AND TO EVALUATE DESIGN CONCEPTS FOR FUTURE UNMANNED AND MANNED SPACE-EXPLORATION VEHICLES CAPABLE OF REENTERING THE EARTH'S ATMOSPHERE AT SPEEDS APPROACHING 20 KM/SEC. THE PROBLEM WILL BE ATTACKED BY (1) STUDIES TO DEFINE THE HEATING ENVIRONMENTS TO BE ENCOUNTERED, AND TO MINIMIZE THE HEATING RATES AND TOTAL HEAT LOADS BY PROPER CHOICE OF TRAJECTORY, VEHICLE SHAPE, HEAT SHIELD MATERIAL, ETC., (2) STUDYING MEANS TO PROMOTE LAMINAR BOUNDARY-LAYER FLOW, (3) EVALUATION OF AVAILABLE MATERIALS IN SIMULATED ENVIRONMENTS COVERING A VARIETY OF ATMOSPHERIC COMPOSITIONS, AND COMBINED CONVECTIVE AND RADIATIVE HEATING AND FRICTION LOADS, AND (4) DEVELOPMENT OF NEW MATERIALS TAILORED TO PROVIDE MAXIMUM HEAT PROTECTION IN PARTICULAR ENVIRONMENTS. KNOWLEDGE OF THE HEATING ENVIRONMENTS AND HEAT-SHIELD MATERIAL PERFORMANCE, AND OF THE EFFECTIVENESS OF THE AERODYNAMIC PARAMETERS AVAILABLE TO MINIMIZE THE HEATING LOAD, IS NECESSARY FOR THE DESIGN OF PROBES WHICH WILL ENTER THE ATMOSPHERES OF VENUS AND THE OUTER PLANETS, AND SPACECRAFT WHICH WILL EXPLORE THE PLANETS AND RETURN TO ENTER THE EARTH'S ATMOSPHERE.

RTOP NO. 124-07-15 TITLE: JUPITER ENTRY AEROTHERMODYNAMIC RESEARCH
ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MCDONALD, R. R. TEL. 213-354-6186

TECHNICAL SUMMARY

A. OBJECTIVE: DUE TO THE INTENSE SCIENTIFIC INTEREST IN AN ATMOSPHERIC PROBE TO THE PLANET JUPITER, THE SOLUTION OF SPACECRAFT HEAT-SHIELD AEROTHERMODYNAMIC PROBLEMS ASSOCIATED WITH THE PROBE ENTRY WILL BE THE PRIMARY OBJECT OF OUR RESEARCH. B. APPROACH: WITH THE PLANNED CAPABILITY FOR PRODUCING SHOCK VELOCITIES UP TO 35 KM/SEC IN OUR MAGNETIC ANNULAR-ARC (MAARC) SHOCK TUBE CURRENTLY UNDER DEVELOPMENT, COMBINED WITH AN EXISTING EXTREME ULTRA-VIOLET TIME-RESOLVED SPECTROMETER TO MEASURE GAS RADIANT FLUX--WE WILL MEASURE THE IMPORTANT SHOCK-HEATED JOVIAN GAS RADIATIVE RELAXATION TIMES, RADIATIVE COOLING EFFECTS ON RADIATIVE FLUX, PRECURSOR AND RADIATIVE FLUX AND ABSORPTION EFFECTS, AND EQUILIBRIUM RADIATIVE EMISSION. OUR CURRENT INVISCID ANALYTICAL TECHNIQUES WILL BE EXTENDED TO INCLUDE MASS TRANSFER AT THE ENTRY PROBE SURFACE TOWARD THE SOLUTION OF GROSS MASSIVE ABLATION EFFECTS AND FORMULATE AND SOLVE THE PROBLEMS OF A VISCOUS RADIATING HYPERSONIC BLUNT BODY FLOW BY THE METHOD OF ASYMPTOTIC EXPANSIONS. C. PROGRESS: COMPUTER PROGRAMS ARE BEING USED TO DETERMINE

VELOCITY-DENSITY-DECELERATION-TEMPERATURE AND ANGLE-OF-ATTACK PROFILES FOR ENTRY OF A PROBE INTO THE ATMOSPHERE OF JUPITER, ALLOWING FOR PLANETARY ROTATION, SKIP-OUT AND RETURN MANEUVERS. ENTRY INTO THE JOVIAN ATMOSPHERE RESULTS IN A THIN SHOCK LAYER ON THE BODY AND SO ALLOWED US TO USE THE VON MISES TRANSFORMATION TO ANALYZE THE RADIATING FLOW-FIELD PROBLEM. THE SOLUTION OF THE NON-ISOTHERMAL SHOCK LAYER USING MONTE CARLO METHODS HAS BEEN ACHIEVED. ENCOURAGING RESULTS HAVE BEEN OBTAINED WITH A DEVELOPMENT VERSION OF OUR MAARC DRIVER WHICH WAS INSTALLED ON AN EXISTING ELECTRIC-ARC SHOCK TUBE. DISTRIBUTED RADIATIVE PLUS CONVECTIVE HEAT FLUX HAS BEEN MEASURED ON AN ENTRY PROBE MODEL. RESULTS AGREE WITH NUMERICAL SOLUTIONS. THE MEASURED N- PHOTOIONIZATION CROSS-SECTIONS AGREE WITH OUR EARLIER THEORETICAL RESULTS. SEVERAL REPORTS ON THERMOCHEMICAL PROPERTIES OF SHOCK-HEATED PLANETARY ATMOSPHERIC GASES WERE PUBLISHED.

RTOP NO. 124-07-17 TITLE: GENERALIZED SPACE VEHICLE AERODYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

TO DETERMINE BY THEORETICAL AND EXPERIMENTAL METHODS THE AERODYNAMIC CHARACTERISTICS OF SHARP AND BLUNT NOSED CONFIGURATIONS FOR BALLISTIC AND LIFTING ATMOSPHERIC ENTRY BODIES IN VARIOUS SPEED RANGES AND TO STUDY THE DYNAMICS OF BODIES AND CONTROL SYSTEMS IN ORDER TO DERIVE METHODS FOR CALCULATING THE MOTION OF BODIES; AND TO DEVELOP METHODS TO REDUCE THE UNCERTAINTIES ASSOCIATED WITH PREDICTING THE AEROTHERMODYNAMICS OF EXPENDABLE AND REUSABLE LAUNCH VEHICLES.

RTOP NO. 124-07-18 TITLE: GENERALIZED REENTRY HEATING AND HEAT
PROTECTION TECHNOLOGY

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK INCLUDES THE DEVELOPMENT OF THE BASIC REENTRY HEATING AND HEAT PROTECTION TECHNOLOGY REQUIRED FOR A BROAD RANGE OF ENVIRONMENTS. FLIGHT VELOCITIES OF INTEREST RANGE FROM 20 K FT/SEC TO 50 K FT/SEC AND ABOVE FOR ENTRY INTO VARIOUS ATMOSPHERES.

IN THE APPROPRIATE VELOCITY REGIME, THE AREAS COVERED INCLUDE HOT GAS RADIATION HEAT TRANSFER, THE COUPLING BETWEEN RADIATION AND THE ABLATION PROCESS, THE TOTAL ABLATION PROCESS, BOUNDARY LAYER TRANSITION INCLUDING ABLATION EFFECTS, AND TURBULENT HEAT TRANSFER WITH AND WITHOUT MASS ADDITION. LIKELY ULTIMATE APPLICATION OF THIS TECHNOLOGY INCLUDES A VARIETY OF MISSIONS REQUIRING EARTH ENTRY AND CERTAIN PLANETARY ENTRY MISSIONS. THE ANALYTICAL APPROACH TO THIS WORK INCLUDES THE DEVELOPMENT AND EXPLOITATION OF COMPREHENSIVE NUMERICAL SOLUTIONS. THE EXPERIMENTAL EFFORT WILL EMPLOY EXISTING GROUND FACILITIES, SOME OF WHICH REQUIRE SOME MODIFICATIONS. EXISTING FLIGHT DATA WILL ALSO BE UTILIZED IN THIS WORK AND AN EFFORT TO DEFINE CRITICAL RESEARCH FLIGHT EXPERIMENTS WILL BE PURSUED.

RTOP NO. 124-07-23 TITLE: DECELERATOR TECHNOLOGY FOR PLANETARY
PROBE/LANDER TERMINAL DESCENT

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

TO PROVIDE THE TECHNOLOGY REQUIRED FOR EFFICIENT DESIGN AND DEVELOPMENT OF PARACHUTES, OTHER TOWED DECELERATORS, AND ATTACHED DECELERATORS HAVING APPLICATION TO PLANETARY ENTRY AND LANDING. TO PROVIDE AN UNDERSTANDING OF SIMILARITY LAWS, DEPLOYMENT AND INFLATION DYNAMICS, AERODYNAMIC PERFORMANCE AND STABILITY OF DECELERATOR AND DECELERATOR-VEHICLE COMBINATIONS. TO DEVELOP AN UNDERSTANDING OF THE FLIGHT BEHAVIOR AND FABRICATION REQUIREMENTS OF FLEXIBLE FABRIC MATERIALS THAT ARE UNCOATED AND MATERIALS THAT ARE COATED TO REDUCE POROSITY OR PROVIDE PASSIVE THERMAL PROTECTION. COMPREHENSIVE IN-HOUSE AND CONTRACT ANALYTICAL AND WIND TUNNEL TEST PROGRAMS WILL LEAD TO SELECTED FLIGHT TESTS FOR DECELERATOR EVALUATION AND TECHNOLOGY DEMONSTRATION. THE RESULTS WILL SUPPORT DECELERATOR DESIGN FOR VIKING AND PROVIDE THE BASIS FOR DECELERATOR CHOICE AND DESIGN FOR LATER ADVANCED MISSIONS.

RTOP NO. 124-07-24 TITLE: MANNED SPACE SHUTTLE: CONFIGURATION,
AEROTHERMODYNAMIC, AND SYSTEMS ANALYSIS
STUDIES

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

SEVERAL MANNED SPACE SHUTTLE CONCEPTS OF THE FULLY-REUSABLE TYPE ARE CURRENTLY BEING CONSIDERED BY NASA/DOD TO SUPPORT FUTURE SPACE STATIONS AND SPACE BASE OPERATIONS, AS WELL AS FOR SHORT-DURATION INDEPENDENT MISSIONS. TO IDENTIFY THE MOST PROMISING CONCEPT, THERE IS A NEED TO EVALUATE CONFIGURATIONS REPRESENTATIVE OF CANDIDATE CONCEPTS, IDENTIFY PROBLEMS AND SOLUTIONS, AND ADVANCE TECHNOLOGY WHERE REQUIRED. THIS RTOP COMPASSES THE ACTIVITIES OF THE LANGLEY COORDINATED SPACE SHUTTLE TECHNOLOGY PROGRAM THE BROAD AREAS OF CONFIGURATION ASSESSMENT AND AEROTHERMODYNAMICS UNDER THE AUSPICES OF THE SPACE SYSTEMS RESEARCH DIVISION, AND IS DIRECTED TOWARD SUPPORT OF PHASE B AND ONGOING STUDIES. THIS WORK WILL BE DONE IN THE FOLLOWING MANNER IN CONJUNCTION WITH WORK COVERED BY OTHER LANGLEY SPACE SHUTTLE RTOP'S IN THE AREAS OF MISSION ANALYSIS/OPERATIONS, STRUCTURES AND THERMAL PROTECTION, AND DYNAMIC LOADS AND AEROELASTICITY. 1. THROUGH SELECTIVELY EXAMINING THE AEROTHERMODYNAMIC CHARACTERISTICS OF PHASE B AND OF REPRESENTATIVE IN-HOUSE CONCEPTS OVER THE TOTAL SPECTRUM OF SYSTEM ENVIRONMENTS (ASCENT, SEPARATION, ORBIT, RETURN, AND LANDING), A NARROWING OF THE SHUTTLE SYSTEM CANDIDATES TO A SELECTED FEW WILL BE EFFECTED. 2. A MORE REFINED, DETAILED ANALYSIS OF THE REMAINING CANDIDATES WILL LEAD TO A FINAL SELECTION. BOTH IN-HOUSE AND CONTRACTUAL EFFORTS WILL BE INCLUDED IN THE ACTIVITIES.

RTOP NO. 124-07-26 TITLE: MANNED SPACE SHUTTLE (CATEGORY I):
DEVELOPMENT OF THERMAL PROTECTION SYSTEMS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE OF THE OUTLINED PROGRAM IS TO INVESTIGATE THERMAL PROTECTION SYSTEMS FOR MANNED SPACE SHUTTLES, TO ASSESS THE ADEQUACY OF EXISTING TECHNOLOGY, AND TO IDENTIFY AND IMPLEMENT REQUIRED DEVELOPMENTS. THIS WILL BE ACCOMPLISHED PRIMARILY BY CONTRACT WORK SUPPORTED BY IN-HOUSE STUDIES AND TESTING. THREE TYPES OF HEAT SHIELDS WILL BE CONSIDERED: LOW-COST ABLATIVE SHIELDS, NON-METALLIC RADIATIVE-INSULATIVE SHIELDS, AND METALLIC RADIATIVE SHIELDS. FIBROUS INSULATION MATERIALS, NON-DESTRUCTIVE TEST TECHNIQUES, AND SOME ASPECTS OF FILM AND CONVECTION COOLING WILL ALSO BE INVESTIGATED. PARAMETRIC HEAT-SHIELD STUDIES WILL ALSO BE MADE TO PROVIDE RATIONAL AND UP-TO-DATE ESTIMATES OF THE WEIGHT AND COST OF SYSTEMS INVOLVING ABLATORS, RADIATORS, INSULATORS, AND ACTIVE COOLING. LARGE-SCALE THERMAL PROTECTION SYSTEMS WILL BE DESIGNED, FABRICATED, AND TESTED TO VALIDATE ANALYTICAL RESULTS, WEIGHTS AND POSSIBLY COSTS. THE RESULTS OF THESE STUDIES WILL PROVIDE INFORMATION WHICH WILL SERVE AS A BASIS FOR THE SELECTION AND DESIGN OF THERMAL PROTECTION SYSTEMS FOR MANNED SPACE SHUTTLES.

RTOP NO. 124-07-27 TITLE: MANNED SPACE SHUTTLE: OPERATIONAL
ANALYSIS STUDIES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

THIS RTOP IS ONE COMPONENT OF THE LANGLEY COORDINATED SPACE SHUTTLE TECHNOLOGY PROGRAM. THE WORK WILL INCLUDE BASIC RESEARCH DIRECTED TOWARD THE DEVELOPMENT OF TECHNOLOGY APPLICABLE TO THE PECULIAR REQUIREMENTS OF THE SPACE SHUTTLE IN THE AREAS OF ENERGY MANAGEMENT AND OPERATIONAL ANALYSIS. IN ADDITION, WORK IN THESE AREAS WILL BE CONDUCTED IN SUPPORT OF THE SPACE SHUTTLE RTOP'S ON AEROTHERMAL, STABILITY AND CONTROL CHARACTERISTICS AND ON THERMAL PROTECTION SYSTEMS. DURING THE PHASE B STUDY, THE WORK WILL BE DIRECTED TOWARD CONCEPT EVALUATION BY SELECTIVELY EXAMINING THE CHARACTERISTICS OF CONCEPTS OVER THE SPECTRUM OF ATMOSPHERIC ENVIRONMENTS. THE INITIAL PHASE OF THE WORK WILL INCLUDE DEFINITION AND EVALUATION OF CONCEPTUAL OPERATIONAL MODES DESIGNED TO OVERCOME PROBLEMS ASSOCIATED WITH ENERGY MANAGEMENT. AS THE NUMBER OF CANDIDATES IS REDUCED, THE SCOPE OF THE OPERATIONAL ANALYSIS STUDIES WILL BROADEN TO ENCOMPASS ALL MISSION PHASES FROM LAUNCH TO LANDING AND TURNAROUND. OPERATIONAL AND MISSION ANALYSIS STUDIES WILL ALSO BE PERFORMED ON ADVANCED MANNED SPACE SYSTEMS.

RTOP NO. 124-07-28 TITLE: MANNED SPACE SHUTTLE: AEROTHERMODYNAMICS
OF BOTH LOW AND HIGH CROSS RANGE CONCEPTS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

TO EVALUATE THE AERODYNAMIC PERFORMANCE, STABILITY AND CONTROL, AND HEATING OF SPACE SHUTTLE VEHICLES PROPOSED FOR HIGH AND LOW CROSS RANGE; TO PINPOINT AND FIND THE SOLUTION TO AEROTHERMODYNAMIC PROBLEMS OF THESE VEHICLES IN SUPPORT OF PHASE B STUDIES. ACCORDINGLY, MODELS OF ORBITERS RESULTING FROM CONTRACTOR AND IN-HOUSE STUDIES WILL BE TESTED IN SUBSONIC, TRANSONIC, SUPERSONIC AND HYPERSONIC FACILITIES. SHADOWGRAPH AND OIL FLOW PHOTOGRAPHS AND HEAT TRANSFER DATA WILL BE OBTAINED AT HYPERSONIC SPEEDS AND 6-COMPONENT FORCE AND MOMENT DATA WILL BE OBTAINED THROUGHOUT THE SPEED RANGE. TECHNIQUES WILL BE DEVELOPED FOR PREDICTING THE INVISCID AND VISCOUS FLOW FIELDS AND HEAT TRANSFER TO FACILITATE THE ASSESSMENT OF ESTIMATES OF OTHERS AND THE EXTRAPOLATION OF WIND TUNNEL RESULTS TO FLIGHT CONDITIONS.

RTOP NO. 124-07-29 TITLE: MANNED SPACE SHUTTLE: DEVELOPMENT AND
EVALUATION OF HEAT SHIELD MATERIALS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

CANDIDATE MATERIALS FOR USE IN SPACE SHUTTLE THERMAL PROTECTION SYSTEMS WILL BE EVALUATED TO DETERMINE PERFORMANCE AND TO IDENTIFY FAILURE MODES. SAMPLES OF CANDIDATE MATERIALS (METALLIC AND NON-METALLIC) WILL BE TESTED IN ARC-JET FACILITIES CAPABLE OF DUPLICATING A NUMBER OF FULL-SCALE FLIGHT CONDITIONS. HEAT SHIELD MATERIALS TO BE INVESTIGATED INCLUDE TDNCR, IMPREGNATED POLYBENZIMIDIZOL (PBI), CARBON PHENOLIC, SILICA PHENOLIC AND HARDENED COMPACTED FIBERS. EMPHASIS WILL BE UPON THE EVALUATION AND DEVELOPMENT OF MATERIALS WHICH REQUIRE LITTLE OR NO REFURBISHMENT.

RTOP NO. 124-07-30 TITLE: SPACE SHUTTLE - THERMAL PROTECTION SYSTEM
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: GREENSHIELDS, D. TEL. 713-483-3676
TECHNICAL SUMMARY

SURFACE INSULATIONS PROMISE TO ALLOW THE USE OF BASICALLY SIMPLER THERMAL PROTECTION DESIGNS IN THE SHUTTLE VEHICLE, SINCE THEY COMBINE THE RERADIATING SURFACE WITH THE SUBSURFACE INSULATION. THUS, ALL STRUCTURE ELEMENTS CAN BE DESIGNED FOR LOW OR MODERATE TEMPERATURES, AND THE NECESSITY OF A SEPARATE HEAT SHIELD STRUCTURE FOR MANY AREAS CAN BE COMPLETELY ELIMINATED. HOWEVER, SUCH MATERIALS ARE NEWLY DEVELOPED AND POSE UNIQUE DESIGN PROBLEMS FOR WHICH TYPICAL SOLUTIONS MUST BE DEVELOPED AND THEIR ADEQUACY DEMONSTRATED. UNDER THIS RTOP, FURTHER DEVELOPMENT OF THE MATERIAL AND MATERIAL CHARACTERIZATION WILL BE PURSUED, AND THE SOLUTION TO DESIGN APPLICATION PROBLEMS DEVELOPED AND DEMONSTRATED BY TYPICAL COMPONENTS TESTING. MOST SHUTTLE DESIGNS INDICATE AREAS ON THE LEADING SURFACES

WHICH EXCEED 2500 DEGREES F DURING ENTRY. FOR THESE AREAS, CARBON-CARBON COMPOSITES WHICH HAVE BEEN TREATED FOR PROTECTION FROM OXIDATION CONSTITUTE THE MOST PROMISING REUSABLE HEAT SHIELD MATERIALS. HOWEVER, EXTENSIVE CHARACTERIZATION AND MATERIALS DEVELOPMENT ARE REQUIRED, AND DESIGN PROBLEMS UNIQUE TO THE RELATIVELY BRITTLE MATERIALS MUST BE SOLVED. UNDER THIS RTOP WORK BOTH IN THE MATERIAL AND DESIGN APPROACH AREAS WILL BE CONDUCTED, AND SAMPLES REPRESENTING TYPICAL APPLICATIONS WILL BE FABRICATED AND EVALUATED.

RTOP NO. 124-07-31 TITLE: PRELIMINARY DESIGN OF A SUBSCALE SPACE SHUTTLE FLIGHT TEST VEHICLE

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: MCTIGUE, J. G. TEL. 805-258-3311

TECHNICAL SUMMARY

INFORMATION REGARDING THE PERFORMANCE AERODYNAMICS, STABILITY, CONTROL, AND HANDLING QUALITIES FOR THE CRITICAL TERMINAL PHASE OF FLIGHT MUST BE PROVIDED FOR THE SELECTED SPACE SHUTTLE VEHICLE CONFIGURATION. THIS RTOP COVERS AN IN-HOUSE PRELIMINARY DESIGN FOR A FLIGHT TEST VEHICLE WHICH CAN PROVIDE THIS INFORMATION IN THE LOW TO MACH 2+ SPEED RANGE IN A TIMELY MANNER AND WITH A LOW COST, FLIGHT PROGRAM SIMILAR TO THE CURRENT FRC LIFTING BODY PROGRAM. THIS DESIGN EFFORT WILL ALSO DEFINE THE FLIGHT TEST VEHICLE SIZE, WEIGHT, PERFORMANCE CHARACTERISTICS, DESIGN LIMITS AND CRITERIA, AND OPERATIONAL ENVELOPE. AT THE COMPLETION OF THIS DESIGN EFFORT AND DEFINITION OF A SINGLE SPACE SHUTTLE CONFIGURATION BY NASA, THE FRC WILL BE IN A POSITION TO RELEASE AN RFP FOR THE DETAILED DESIGN AND CONSTRUCTION OF A FLIGHT TEST VEHICLE.

RTOP NO. 124-07-32 TITLE: MANNED SPACE SHUTTLE (CAT. II) TERMINAL FLIGHT OPERATIONS ANALYSIS (SIMULATION OF TERMINAL FLIGHT PROBLEMS IN ACTUAL FLIGHT

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: LAYTON, G. P. TEL. 805-258-3311

TECHNICAL SUMMARY

THE PURPOSE OF THIS STUDY IS TO DEFINE THE SPECIAL REQUIREMENTS TO BE MET BY BOTH THE LIFTING REENTRY VEHICLE, AND THE AIR TRAFFIC CONTROL SYSTEM TO ALLOW OPERATIONAL SPACE SHUTTLE FLIGHTS. THIS WORK INCLUDES STUDY OF POWERED AND UNPOWERED IFR RECOVERY TECHNIQUES, AND AIR TRAFFIC PROCEDURES.

RTOP NO. 124-07-38 TITLE: ARC-JET SIMULATION OF FLOW FIELD ENVIRONMENT FOR THE GIANT PLANETS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

THE OBJECTIVE IS TO DERIVE THE TECHNOLOGY BASE NECESSARY TO DESIGN AND BUILD THE VERY HIGH PERFORMANCE ARC PLASMA GENERATORS

NEEDED FOR SIMULATION OF ENTRIES INTO THE ATMOSPHERES OF THE GIANT PLANETS. FLOW GENERATORS WILL BE DEVELOPED WHICH WILL BE CAPABLE OF OPERATING WITH A VARIETY OF GASES, WILL HAVE POWER FLOW DENSITIES ABOUT ONE MEGAWATT PER SQUARE CENTIMETER OF TEST SECTION AREA, WILL GENERATE COMBINED CONVECTIVE AND RADIATIVE HEAT TRANSFER RATES OF 20 KW/SQ CM, AT IMPACT PRESSURES FROM 2 TO 5 ATMOSPHERE, AND WILL OPERATE FOR TIME INTERVALS UP TO 10 SECONDS. ARC OPERATING PARAMETERS WILL BE DETERMINED WHICH WILL PERMIT SCALING OF POWER, PRESSURE, AND SIZE FROM PRESENT LEVELS TO THOSE REQUIRED FOR SIMULATION. INITIALLY AN EXISTING 6-CM PULSED, CONSTRICTED ARC WILL BE MODIFIED INTO A PILOT PLASMA FLOW FACILITY THAT WILL PRODUCE ENTHALPY LEVELS AND COMBINED CONVECTIVE AND RADIATIVE HEATING APPROACHING THOSE FOR A SHALLOW ENTRY INTO THE JUPITER ATMOSPHERE. THE TEST TIMES WILL BE UP TO 5 SECONDS, LONG ENOUGH TO CONDUCT MATERIAL RESPONSE STUDIES. THE ADVENT OF HIGH PERFORMANCE PLASMA GENERATORS WILL PROVIDE THE CAPABILITY TO INVESTIGATE EXPERIMENTALLY THE PROBLEMS OF EXTREME SEVERITY PRESENTED BY ENTRY INTO THE ATMOSPHERES OF THE OUTER PLANETS. IN THE LIMIT, THE ASSURANCE WITH WHICH THE HEAT SHIELD OF A PROBE CAN BE DESIGNED WILL DETERMINE THE ALLOWABLE WEIGHT OF THE SCIENTIFIC PAYLOAD.

RTOP NO. 124-08-10 TITLE: ADVANCED STRUCTURAL CONCEPTS AND MATERIALS APPLICATIONS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOPE NEW STRUCTURAL CONCEPTS AND ADVANCED MATERIALS INCLUDING COMPOSITES, FABRICS, AND MEMBRANE MATERIALS FOR FLEXIBLE OR RIGID SPACE STRUCTURAL APPLICATIONS. THE WORK CONSISTS OF ANALYTICAL AND EXPERIMENTAL STUDIES OF FILAMENTARY COMPOSITE MATERIALS, EVALUATION, CHARACTERIZATION, AND STUDY OF FABRIC MATERIALS TO BETTER DEFINE MATERIAL CAPABILITES AND STRUCTURAL REQUIREMENTS, DEVELOPEMENT OF ADVANCED POLYMERS FOR SPACECRAFT APPLICATIONS, DEVELOPEMENT OF UNIQUE MECHANISMS APPLICABLE TO SPACECRAFT HARDWARE, AND INVESTIGATION OF SELF-ERECTABLE STRUCTURES FROM A NICKEL-TITANIUM MATERIAL. A PORTION OF THIS PROGRAM WILL BE ACCOMPLISHED BY CONTRACT TO SUPPORT THE IN-HOUSE EFFORTS. THE RESULTS OF THESE STUDIES WILL LEAD TO A BETTER UNDERSTANDING OF CAPABILITIES OF ADVANCED FILAMENTARY AND FABRIC MATERIALS THAT MAY LEAD TO POTENTIAL IMPROVEMENTS IN STRUCTURAL EFFICIENCY, WILL PROVIDE FEASIBILITY FOR PERFORMING DEFINED MISSIONS, OR WILL IDENTIFY NEW APPLICATIONS OR MISSION POSSIBILITIES.

RTOP NO. 124-08-12 TITLE: NASTRAN (NASA STRUCTURAL ANALYSIS) PROGRAM ORGANIZATION: GODDARD SPACE FLIGHT CTR.

MONITOR: FORLIFER, W. R. TEL. 301-982-4245

TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THIS EFFORT IS TO DEVELOP FOR NASA A HIGHLY EFFICIENT GENERAL PURPOSE COMPUTER PROGRAM FOR STRUCTURAL ANALYSIS. THERE ARE, AT PRESENT, A GREAT NUMBER OF SPECIAL PURPOSE

COMPUTER PROGRAMS FOR SOLVING VARIOUS PARTS OF THE TOTAL STRUCTURAL ANALYSIS PROBLEM. THE USE OF THESE PROGRAMS FOR LARGE PROBLEMS IS GENERALLY HIGHLY INEFFICIENT AND WHEN DIFFERENT PROGRAMS ARE USED IN THE ANALYSIS OF DIFFERENT PARTS OF THE TOTAL SPACE VEHICLE, THE RESULTS ARE DIFFICULT TO COMMUNICATE AND INTEGRATE BY NASA CENTERS AND THEIR CONTRACTORS. NASTRAN PROVIDES A STANDARD GENERAL PURPOSE PROGRAM WHICH CAN BE EFFICIENTLY USED ON LARGE PROBLEMS, INCLUDING THE TOTAL SPACE VEHICLE.

RTOP NO. 124-08-12 TITLE: NASTRAN (NASA STRUCTURAL ANALYSIS)
MANAGEMENT

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K. TEL. 703-827-2887

TECHNICAL SUMMARY

TO PROVIDE NASA WITH THE MANAGEMENT OF THE MANAGEMENT OF THE CONTINUED DEVELOPMENT AND MAINTENANCE OF THE NASTRAN COMPUTER PROGRAM FOR STRUCTURAL ANALYSIS. THIS DEVELOPMENT AND MAINTENANCE WILL BE CARRIED OUT THROUGH A MASTER AGREEMENT TYPE CONTRACT UNDER THE DIRECTION OF THE NASTRAN SYSTEMS MANAGEMENT OFFICE. THE PRIMARY OBJECTIVE IS TO CONTINUOUSLY MAINTAIN NASTRAN AS A STANDARDIZED MODERN STATE-OF-THE-ART STRUCTURAL ANALYSIS TOOL FOR NASA AND THE AEROSPACE TECHNICAL COMMUNITY.

RTOP NO. 124-08-13 TITLE: LOW-FREQUENCY STRUCTURAL DYNAMICS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO EXPAND THE UNDERSTANDING OF THE LOW FREQUENCY DYNAMIC LOADS ON SPACE VEHICLE STRUCTURES, THE DYNAMIC CHARACTERISTICS OF THE STRUCTURES, AND THE RESPONSE OF STRUCTURES TO LOADS. BOTH ANALYTICAL AND EXPERIMENTAL APPROACHES WILL BE UTILIZED TO DETERMINE INPUTS, STRUCTURAL SYSTEM TRANSFER FUNCTIONS, AND RESPONSES OF LAUNCH VEHICLE, SPACE SHUTTLE, SPACECRAFT, ORBITAL BASE, AND ENTRY VEHICLE CONFIGURATIONS. WIND TUNNELS AND DYNAMIC MODELS WILL BE USED EXTENSIVELY FOR THIS ONGOING IN-HOUSE RESEARCH AND WILL BE SUPPLEMENTED BY CONTRACT RESEARCH. THE RESULTS WILL LEAD TO LIGHTER WEIGHT AND MORE RELIABILITY IN CURRENT VEHICLES AND ESTABLISH THE FEASIBILITY AND CONFIGURATIONS OF FUTURE CONCEPTS.

RTOP NO. 124-08-14 TITLE: HIGH FREQUENCY DYNAMICS (TRANSIENT LOADS
AND RESPONSE)

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THIS RESEARCH WILL PROVIDE IMPROVEMENTS IN THE STATE OF THE ART FOR DESIGNING SPACE VEHICLES TO SUSTAIN HIGH FREQUENCY DYNAMIC LOADS. THESE DYNAMIC LOADS MAY BE SINUSOIDAL, RANDOM, OR TRANSIENT IN

NATURE, SUCH AS ACOUSTIC PRESSURES OR PYROTECHNIC SHOCKS, AND OFTEN LEAD TO LOCAL STRUCTURAL FAILURES OR EQUIPMENT MALFUNCTIONS. IMPROVED DEFINITION OF THESE LOADS IS REQUIRED TO DEVELOP MORE ADEQUATE SIMULATION TECHNIQUES, PREPARE MORE REALISTIC TEST SPECIFICATIONS, AND DEVELOP BETTER PROTECTIVE DEVICES FOR SENSITIVE COMPONENTS. ANALYTICAL METHODS MUST ALSO BE DEVELOPED TO PREDICT RESPONSE TO THE LOADS. THE RESEARCH PROGRAM WILL UTILIZE EXISTING FLIGHT DATA, GROUND TESTS, AND FLIGHT TESTS AS WELL AS ANALYSIS AND WILL BE CONDUCTED IN-HOUSE BUT SUPPLEMENTED BY UNIVERSITY GRANTS AND INDUSTRY CONTRACTS. ANY SIGNIFICANT IMPROVEMENTS IN THIS TECHNOLOGY WILL BE IMMEDIATELY APPLICABLE TO ALL FUTURE SPACECRAFT AND CAN LEAD TO REDUCED COST AND IMPROVED RELIABILITY.

RTOP NO. 124-08-15 TITLE: STRUCTURAL MECHANICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

TO DEVELOP BETTER UNDERSTANDING OF FAILURE OF SPACE VEHICLE STRUCTURES THROUGH BASIC ANALYTICAL AND EXPERIMENTAL STUDIES OF COMPONENT STRUCTURES SUBJECTED TO VARIOUS ASPECTS OF THE FLIGHT ENVIRONMENT. TO IMPROVE PROCEDURES FOR DESIGN OF LIGHTER, MORE RELIABLE SPACE VEHICLE STRUCTURES AND REDUCE THE NUMBER OF EXPENSIVE TEST PROGRAMS REQUIRED TO QUALIFY FLIGHT STRUCTURES THROUGH GENERATION OF MORE ACCURATE, THOROUGH AND COMPREHENSIVE ANALYTICAL METHODS.

RTOP NO. 124-08-18 TITLE: SPACE STATION STRUCTURES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

OBJECTIVE - THE RESEARCH CONDUCTED UNDER THIS RTOP WILL BE DIRECTED TOWARD THE STUDY OF METHODS TO PROVIDE AND MAINTAIN LARGE ENCLOSED VOLUMES FOR MANNED SPACE STATIONS. THE OBJECTIVES OF THIS RESEARCH ARE THREEFOLD. TO DEVELOP A DAMAGE CONTROL SYSTEM THAT WILL DETECT, LOCATE, AND REPAIR HOLES OR LEAKS IN THE PRESSURIZED CABINS OF SPACE STATION. TO INSURE THAT NON METALLIC MATERIALS USED IN BOTH PRIMARY AND SECONDARY SPACE STATION STRUCTURES MEET NONFLAMMABILITY AND OUTGASSING STANDARDS. TO PROVIDE THE TECHNOLOGY IN EXPANDABLE STRUCTURES AND ROTATING SEALS REQUIRED FOR THE DESIGN OF AUXILIARY MANNED SPACE STRUCTURES APPLICABLE TO THE SPACE STATION/BASE.

RTOP NO. 124-08-19 TITLE: STRUCTURES FOR ORBITING RADIO TELESCOPES
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: HIBBARD, W. D. TEL. 301-982-4278
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP STRUCTURE TECHNOLOGY NEEDED FOR AN ORBITING RADIO TELESCOPE THAT OPERATES IN THE FREQUENCY RANGE OF 1-10 MHZ; AN ACCURATE PARABOLOIDAL REFLECTOR APPROXIMATELY ONE KILOMETER

IN DIAMETER IS REQUIRED, PLUS SUPPORTING STRUCTURE FOR THE RF FEED AND ELECTRONICS. A CENTRIFUGALLY DEPLOYED FILAMENTARY NET WITH FORE AND AFT STAYS IS THE MOST PROMISING APPROACH. A FIVE METER DIAMETER MODEL HAS BEEN DEVELOPED AND SUCCESSFULLY TESTED IN VACUUM ENVIRONMENT. ADDITIONAL TESTING, INCLUDING AN AEROBEE FLIGHT, IS PLANNED. PRELIMINARY STUDIES OF A 50 METER MODEL ARE UNDER WAY, AND A CONTINUING EFFORT IS DEVOTED TO DEFINING AND ANALYZING THE ULTIMATE TELESCOPE REQUIREMENTS.

RTOP NO. 124-08-20 TITLE: PLANETARY ENTRY AND LANDING STRUCTURES

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO DEVELOP AND VALIDATE THE STRUCTURAL TECHNOLOGY FOR EFFICIENT DESIGN OF BOTH LIGHT WEIGHT ENTRY SPACECRAFT AND PLANETARY LANDING GEAR SYSTEMS. THE OBJECTIVES WILL BE ACHIEVED THROUGH NUMERICAL METHOD DEVELOPMENT, COMPREHENSIVE ANALYTICAL DESIGN STUDIES, AND FABRICATION AND TEST OF PRACTICAL AEROSHELL CONFIGURATION, LANDING IMPACT ATTENUATION SYSTEMS, AND DYNAMIC MODELS.

RTOP NO. 124-08-26 TITLE: SPACECRAFT COMMUNICATIONS ANTENNA STRUCTURES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MCDONALD, R. R. TEL. 213-354-6186

TECHNICAL SUMMARY

OUTER PLANET AND PLANETARY ORBIT MISSIONS IN THE 1975-1985 PERIOD WILL REQUIRE SUBSTANTIALLY INCREASED COMMUNICATION CAPABILITIES. JPL STUDIES INDICATE THAT OPTIMUM TELECOMMUNICATIONS SUBSYSTEM DESIGN FOR THESE MISSIONS IS REALIZED WITH ANTENNAS HAVING MUCH HIGHER GAIN THAN THOSE NOW USED ON MARINER SPACECRAFT; HOWEVER, THE ASSUMED GAIN VS. WEIGHT USED IN THESE STUDIES HAS NOT BEEN VERIFIED, NOR IS THE TECHNOLOGY FOR THESE LARGER ANTENNAS SUFFICIENTLY WELL DEVELOPED. THE PRINCIPAL OBJECTIVE OF THIS THREE YEAR TASK IS TO FULFILL THE NEED TO DEVELOP AND MAKE AVAILABLE THE KNOWLEDGE REQUIRED BY FLIGHT PROJECT TO BE ABLE TO UTILIZE NEW LARGE ANTENNAS. A NUMBER OF ANTENNA CONFIGURATIONS WILL BE CONSIDERED, INCLUDING PARABOLOIDAL ANTENNAS FROM 15 TO 100 FEET IN DIAMETER, WHICH WILL NECESSARILY BE UNFURLABLE. OPERATING FREQUENCIES UP TO X-BAND WILL BE CONSIDERED. THE SELECTED APPROACH IS TO FIRST INVESTIGATE UNFURLABLE HIGH GAIN ANTENNA CONCEPTS APPLICABLE TO THE RANGE OF SIZES AND THE OPERATING FREQUENCIES OF INTEREST, AND TO DEVELOP THE ANALYTIC CAPABILITIES AND MATERIALS EXPERTISE NECESSARY TO SUPPORT THESE INVESTIGATIONS. CRITERIA WHICH WILL BE CONSIDERED INCLUDE: WEIGHT (GOAL IS 0.25 LB/FT SQUARED OR BETTER), SURFACE ACCURACY IN THE OPERATING ENVIRONMENT, RELIABILITY OF DEPLOYMENT, LONG LIFE, NATURAL FREQUENCY INTERACTION WITH THE ATTITUDE CONTROL SUBSYSTEM, AND AMENABILITY TO PRE-FLIGHT VERIFICATION BY ANALYSIS AND TEST. FOLLOWING THIS FIRST PHASE A SPECIFIC ANTENNA BEST TYPIFYING ANTICIPATED REQUIREMENTS WILL BE DESIGNED AND APPROPRIATE HARDWARE

WILL BE FABRICATED AND TESTED. THE EFFORT ON THIS MECHANICAL TASK WILL BE COORDINATED WITH MICROWAVE DEEP SPACE COMMUNICATIONS & TRACKING, RTOP CODE 125-21-09. IT SHOULD BE NOTED THAT A 14-FOOT-DIAMETER UNFURLABLE X-BAND ANTENNA IS BEING DEVELOPED FOR RTOPS.

RTOP NO. 124-08-28 TITLE: ADVANCED STRUCTURAL AND DYNAMIC STUDIES
ORGANIZATION: NASA HEADQUARTERS
MONITOR: ROSCHE, M. G. TEL. 202-962-0151
TECHNICAL SUMMARY

THE OBJECTIVES ARE TO PROVIDE ASSESSMENTS AND SUMMARIES OF THE STATE-OF-THE-ART IN STRUCTURES/MATERIALS TECHNOLOGY, MAKE CRITICAL EXAMINATIONS IN CRUCIAL AREAS TO GUIDE FUTURE RESEARCH, CONDUCT INITIAL EXPLORATORY RESEARCH TO DEFINE FUTURE FRUITFUL DIRECTION, AND INITIATE NEW EFFORT AS A NUCLEUS FOR LATER CENTER PROGRAMS. SPECIFIC OBJECTIVES INCLUDE THE FOLLOWING ITEMS: A. CONTINUATION OF STUDIES OF ADVANCED SPINNING NETWORK CONCEPTS, THERMALLY STABLE STRUCTURES, AND ADVANCED COMPOSITES. B. TO PROVIDE A FOCAL POINT AND SOURCE FOR SHOCK AND VIBRATION INFORMATION.

RTOP NO. 124-08-29 TITLE: DYNAMIC INTERACTIONS OF GASES, FLUIDS, PARTICLES AND STRUCTURES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE IS TO INVESTIGATE PHENOMENA PECULIAR TO SPACE MISSIONS WHICH INVOLVE THE DYNAMIC BEHAVIOR OF FLUIDS CONTAINED IN STRUCTURES DURING VARIOUS PHASES OF SPACE FLIGHT, OF ROCKET EXHAUST FLOWS INTERACTING WITH SURFACES, AND OF LUNAR OR PLANETARY PARTICULATE SURFACES SUBJECTED TO SPACECRAFT LANDINGS, TO SITE SAMPLING OR TO SITE DEVELOPMENT. THE APPROACH BEING TAKEN INVOLVES CARRYING OUT EXPERIMENTAL AND ANALYTICAL STUDIES TO DETERMINE THE DYNAMIC BEHAVIOR OF GASES, FLUIDS AND PARTICLES ALONE, IN COMBINATION, AND WITH INTERACTING STRUCTURES. AREAS INVESTIGATED WILL INCLUDE NEAR AND FAR-FIELD JET EXHAUST BEHAVIOR, DYNAMIC BEHAVIOR OF LIQUIDS AND CONTAINING STRUCTURES INCLUDING LIQUID-LEVEL SENSOR AND ANTI-SLOSH DEVICES; PHYSICAL PROPERTIES OF VARIOUS CANDIDATE PARTICULATE SURFACES FOR THE MOON AND PLANETS; AND BEHAVIOR OF SUCH SURFACES WHEN DISTURBED, SUCH AS BY IMPACTING BODIES, JETS, OR EXPLOSIVES. EFFECTS OF EXTRATERRESTRIAL ENVIRONMENTAL FACTORS (REDUCED GRAVITY, REDUCED AMBIENT PRESSURES, ETC.) ON DYNAMIC BEHAVIOR WILL BE CONSIDERED. LIKELY APPLICATIONS IN SPACE MISSIONS INCLUDE THE CONFIGURING OF: LIQUID TANKAGE FOR LAUNCH VEHICLES AND SPACECRAFT; EXHAUST JETS AND JET OPERATION REQUIRED NEAR STRUCTURAL OR EXTRATERRESTRIAL SURFACES TO MINIMIZE RISK OF VEHICLE DAMAGE OR INTERFERENCE WITH SCIENTIFIC MEASUREMENTS; AND STRUCTURES, VEHICLES, AND SITE DEVELOPMENT TECHNIQUES INVOLVED IN LUNAR OR PLANETARY LANDINGS, BASE OPERATIONS, OR SURFACE EXPLORATION.

RTOP NO. 124-08-30 TITLE: MANNED SPACE SHUTTLE (CATEGORY 1):
STRUCTURAL DESIGN TECHNOLOGY

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE GOAL IS DEVELOPMENT OF IMPORTANT TECHNOLOGY FOR PRECISE, EFFICIENT DESIGN OF SPACE SHUTTLE STRUCTURES. THE WORK WILL BE ACCOMPLISHED THROUGH NUMEROUS CONTRACTUAL ARRANGEMENTS WITH THE TOTAL SPECTRUM OF INTERESTED AEROSPACE COMPANIES. TIMELY, COMPREHENSIVE DEFINITION AND DOCUMENTATION OF STRUCTURAL DESIGN CRITERIA IS BEING ACCOMPLISHED THROUGH THE LANGLEY SVDCO. IMPROVED METHODS OF DESIGN ANALYSIS WILL BE ACHIEVED THROUGH IMPROVEMENTS TO THE NASTRAN FINITE ELEMENT PROGRAM. ADVANCED STRUCTURAL CONCEPTS WILL BE DEVELOPED FOR APPLICATION TO THE SHUTTLE TO SAVE WEIGHT. A MAJOR PROGRAM TOWARD APPLICATION OF CONCEPTS OF SELECTIVE REINFORCEMENT OF METAL STRUCTURES WITH ADVANCED FILAMENTARY COMPOSITES IS INCLUDED. OF SPECIAL IMPORTANCE WILL BE AN IN-DEPTH COMPARATIVE DESIGN STUDY TO IDENTIFY OPTIMUM STRUCTURE/TPS ARRANGEMENTS FOR THE SHUTTLE STAGES. ALSO IMPORTANT WILL BE AN EXTENSIVE RESEARCH PROGRAM ON DESIGN OF SECONDARY STRUCTURES, FASTENERS AND MECHANISMS FOR LONG LIFE IN THE SEVERE SHUTTLE ENVIRONMENT.

RTOP NO. 124-08-31 TITLE: SPACE SHUTTLE DYNAMICS AND AEROELASTICITY

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO DEVELOP THE LOADS, STRUCTURAL DYNAMICS, AND AEROELASTICITY TECHNOLOGY OF SPACE SHUTTLE VEHICLES. SPECIFICALLY, TECHNOLOGY TO SOLVE PROBLEMS SUCH AS BUFFET; FLUTTER; PANEL FLUTTER; GROUND WIND LOADS; PROPELLANT SLOSH; WIND, GUST, AND CONTROL LOADS; POGO; BOUNDARY LAYER NOISE; AND SHOCK LOADS WILL BE DEVELOPED. PROPOSED SPACE SHUTTLE CONFIGURATIONS AND OPERATING REQUIREMENTS INTRODUCE THE NEW FACTORS OF ASYMMETRY, PARALLEL-STAGED MULTIBODIES, AND HIGH TEMPERATURE INTO THESE DYNAMICS PROBLEMS. BOTH ANALYTICAL AND EXPERIMENTAL APPROACHES ARE REQUIRED TO DETERMINE CRITICAL LOADING CONDITIONS, VEHICLE CHARACTERISTICS, VEHICLE RESPONSES, AND STABILITY BOUNDARIES. DYNAMIC MODELS AND WIND TUNNELS WILL BE USED EXTENSIVELY FOR THIS IN-HOUSE AND CONTRACT EFFORT. THE RESULTS WILL INFLUENCE CONFIGURATION SELECTION AND LEAD TO LIGHTER WEIGHT AND MORE RELIABILITY IN THE FINAL CONFIGURATION.

RTOP NO. 124-08-33 TITLE: SPACE SHUTTLE MISSION SIMULATION
STRUCTURAL TESTS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

ALL SPECIFIC RESEARCH AND DEVELOPMENT REQUIREMENTS ARE PRESUMED IN THIS STUDY TO DEVELOP A THERMAL PROTECTION SYSTEM FOR THE MANNED SPACE SHUTTLE VEHICLE. THE THERMAL PROTECTION-PRIMARY STRUCTURE SYSTEM IS STUDIED IN THE AREAS OF STRUCTURAL DESIGN, STRUCTURAL

ANALYSIS, THERMAL ENGINEERING, MATERIALS DEVELOPMENT, FABRICATION, INSPECTION AND REFURBISHMENT. DEVELOPED PROTECTION SYSTEMS ARE TO BE FABRICATED AND TESTED IN SIZES PERMITTING SCALING TO A FLIGHT VEHICLE. THE STUDY WILL DEVELOP THE OPTIMUM STRUCTURAL SYSTEMS FOR VARIOUS TEMPERATURE REGIMES TO BE ENCOUNTERED ON THE SPACE SHUTTLE. THE STRUCTURAL SYSTEM CONSISTS OF THE RERADIATIVE OR INSULATING OUTER SKIN, THE HIGH TEMPERATURE INSULATION NECESSARY TO PROTECT THE PRIMARY STRUCTURE, THE PRIMARY LOAD CARRYING STRUCTURE, PROPELLANT CONTAINER AND HIGH PERFORMANCE INSULATION. HIGH TEMPERATURE MATERIALS INCLUDED ARE ALLOYS OF NICKEL, COBALT, TANTALUM, COLUMBIUM, MOLYBDENUM, TUNGSTEN AND NECESSARY COATINGS, COMPACTED FIBROUS INSULATION AND OTHERS. FIBROUS HIGH TEMPERATURE INSULATIONS, ALUMINUM, TITANIUM FIBER COMPOSITES AND FERROUS METALS FOR PRIMARY STRUCTURE AND PROPELLANT TANKS AND HIGH PERFORMANCE CRYOGENIC INSULATION SYSTEMS WILL BE INVESTIGATED.

RTOP NO. 124-08-37 TITLE: SPACE SHUTTLE ADVANCED COMPOSITES FOR
PRIMARY STRUCTURES

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

ALL SPECIFIC RESEARCH AND DEVELOPMENT REQUIREMENTS ARE PRESUMED IN THIS STUDY TO DEVELOP THRUST STRUCTURE CONCEPTS USING ADVANCED COMPOSITE MATERIALS FOR THE MANNED SPACE SHUTTLE VEHICLE. THE THRUST STRUCTURE CONCEPTS TO BE STUDIED ARE IN THE AREAS OF STRUCTURAL DESIGN. DEVELOPED CONCEPTS ARE TO BE FABRICATED AND TESTED IN SIZES PERMITTING SCALING TO A FLIGHT VEHICLE. THE STUDY WILL DEVELOP THE OPTIMUM THRUST STRUCTURE CONCEPTS APPLICABLE FOR VARIOUS ENGINE ARRANGEMENTS BY NUMBER AND SIZE, USING AVAILABLE ADVANCED COMPOSITE SYSTEMS. METAL AND NONMETALLIC MATRICES WITH BORON, GRAPHITE AND OTHER FIBERS WILL BE INVESTIGATED.

RTOP NO. 124-08-39 TITLE: MANNED SPACE SHUTTLE - DYNAMIC LOADS
INCLUDING FLUTTER, BUFFET, AERODYNAMIC
NOISE AND VIBRATION

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

WIND TUNNEL TESTS AND ANALYSIS WILL BE CONDUCTED TO INVESTIGATE SEVERAL DYNAMIC AND AEROELASTIC PROBLEMS THAT MUST BE CONFRONTED IN THE EVALUATION OF CONFIGURATIONS AND THE DEVELOPMENT OF A SPACE SHUTTLE VEHICLE. THE PRIMARY EMPHASIS WILL BE ON TRANSONIC BUFFET (INCLUDING AEROELASTIC EFFECTS), AERODYNAMIC NOISE INPUTS AND RESPONSE, AND PANEL FLUTTER. MOST OF THE WORK WILL BE EXPERIMENTAL. SUCH TESTS ARE NECESSARY SINCE PROPOSED CONFIGURATIONS OF SHUTTLE VEHICLES WILL BE EXPOSED TO STRONG INTERFERENCE FLOWS, OSCILLATING SHOCKS, LARGE AREAS OF SEPARATED FLOW, AND TO POSSIBLE MOTION COUPLED SEPARATION AND ATTACHMENT OF FLOW. THE CONSIDERATION OF FIXED-WING CONFIGURATIONS ALSO INTRODUCES THE POSSIBILITY OF WING BUFFET AT ZERO OR LOW LIFT THROUGHOUT THE TRANSONIC SPEED RANGE. THE WORK PERFORMED

WILL SUPPORT THE EVALUATION OF CANDIDATE SPACE SHUTTLE CONFIGURATIONS FROM A DYNAMIC LOADS POINT OF VIEW, AND WILL PROVIDE UNSTEADY LOADS INFORMATION NEEDED FOR THE DESIGN OF RELIABLE MINIMUM-WEIGHT STRUCTURES.

RTOP NO. 124-08-40 TITLE: COMPOSITE TANKAGE TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: NORED, D. L. TEL. 216-433-6873
TECHNICAL SUMMARY

THE WORK CONDUCTED UNDER THIS RTOP WILL PROVIDE THE TECHNOLOGY FOR FUTURE FILAMENT-WOUND STRUCTURES, PARTICULARLY SPACE SHUTTLE VEHICLE TANKAGE. APPLICATIONS FOR THIS TECHNOLOGY WILL INCLUDE LARGE, LOW-PRESSURE, LOAD-CARRYING, LIQUID PROPELLANT TANKS; NON-INTEGRAL (NON-LOAD CARRYING) LIQUID TANKS; AND SMALL, HIGH-PRESSURE GAS STORAGE VESSELS. FILAMENTS OF GLASS AND OTHER FIBERS WHICH CAN OFFER SIGNIFICANT WEIGHT OR COST SAVINGS, WHILE MAINTAINING OR IMPROVING THE RELIABILITY ATTAINABLE WITH CONVENTIONAL METAL VESSELS, WILL BE EVALUATED. THE DEVELOPMENT OF THE ADVANCED CONCEPTS FOR FILAMENT-WOUND PRESSURE VESSELS ALREADY IN PROGRESS WILL BE CONTINUED. IN F.Y. 1971, ADDITIONAL ACTIVITIES WILL BE SPECIFICALLY DIRECTED TOWARDS THE DESIGN REQUIREMENTS OF THE SPACE SHUTTLE VEHICLE SYSTEM.

RTOP NO. 124-08-41 TITLE: CRYOGENIC STORAGE TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: NORED, D. L. TEL. 216-433-4000
TECHNICAL SUMMARY

THE WORK CONDUCTED UNDER THIS RTOP WILL PROVIDE NECESSARY TECHNOLOGY REQUIRED FOR EFFECTIVE DESIGN AND FABRICATION OF CRYOGENIC THERMAL PROTECTION AND STORAGE SYSTEMS FOR THE SPACE SHUTTLE VEHICLE. THE EFFORT WILL ALSO SUPPORT THE SPACE STATION AND FUTURE PLANETARY OR LUNAR EXPLORATION VEHICLES. FOR THE SPACE SHUTTLE, WORK WILL BE CONDUCTED ON STORAGE SYSTEMS DESIGNED TO MEET THE PROBLEMS OF GROUND HOLD, LAUNCH ASCENT, REENTRY THROUGH THE EARTH'S ATMOSPHERE, AND REUSE. THE USE OF INTERNAL, GAS BARRIER TYPE, INSULATION WILL BE EVALUATED FOR THE ASCENT TANKS. WORK ON A UNIQUE SELF-EVACUATING MULTI-LAYER INSULATION SYSTEM CONCEPT WILL BE CONTINUED, FOR THE PARTICULAR REQUIREMENTS OF THE SPACE SHUTTLE TANKS IN BOTH THE BOOSTER AND ORBITER. FOR THE ORBITER, POSSIBLE USE OF VACUUM JACKET CONCEPTS WILL BE STUDIED. IN ADDITION TO THE STORAGE SYSTEM WORK, INVESTIGATIONS WILL BE CONDUCTED ON ZERO AND REDUCED GRAVITY FLUID BEHAVIOR AS APPLIED TO PROPELLANT ORIENTATION, PROPELLANT TRANSFER, HEAT TRANSFER PHENOMENA AND INTERFACE CONTROL UTILIZING SURFACE ENERGY FORCES. TO SUPPORT THE ABOVE AREAS, GENERAL TECHNOLOGY PROGRAMS WILL BE CONTINUED TO OBTAIN A BETTER UNDERSTANDING OF MULTILAYER INSULATION, TO CONDUCT SUPPORTING STUDIES ON ADVANCED SPACE MISSIONS IN ORDER TO DEFINE VEHICLE REQUIREMENTS, AND TO EVALUATE SHADOW SHIELD SYSTEMS, TANK SUPPORTS, AND TANK VENTING SYSTEMS. ADDITIONAL EFFORT REQUIRED FOR THE SUPPORT OF THE CRYOGENIC STORAGE AND HANDLING AREA WILL BE CONDUCTED, AS NECESSARY.

RTOP NO. 124-08-42 TITLE: FRACTURE MECHANICS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SMITH, G. T. TEL. 216-433-4000
TECHNICAL SUMMARY

THE WORK CONDUCTED UNDER THIS RTOP WILL BE DIRECTED TO PROVIDING DATA, DESIGN METHODS, AND APPLIED TECHNOLOGY REQUIRED FOR THE DESIGN, EVALUATION AND OPERATIONAL CONTROL OF SPACE SHUTTLE VEHICLE PRESSURE VESSELS. IN ADDITION, GENERAL SUPPORTING TECHNOLOGY EFFORTS WILL BE CONDUCTED. A MAJOR PORTION OF THE TECHNOLOGY RESULTING FROM THESE PROGRAMS WILL ALSO BE APPLICABLE TO PRESSURE VESSELS OF THE SPACE STATION AND TO UPPER STAGE UNMANNED PLANETARY VEHICLES. SPECIFIC AREAS TO BE UNDERTAKEN INCLUDE: (1) DEVELOPMENT OF FLAW EXTENSION DATA (BOTH CRITICAL AND SUBCRITICAL) FOR FLAWS WHICH ARE DEEP WITH RESPECT TO THE TANK WALL THICKNESS; (2) EVALUATION OF FLAW PROPAGATION CHARACTERISTICS OF MATERIALS UNDER CONDITIONS OF COMBINED LOADING, CHARACTERISTIC OF SHUTTLE VEHICLE TANKS; (3) DEVELOPMENT OF SYSTEMATIC METHODS OF PRESSURE VESSEL DESIGN WHICH INCORPORATE THE MOST RECENT FRACTURE MECHANICS TECHNOLOGY ADVANCEMENTS; (4) EVALUATION OF THE INTERACTION EFFECTS OF COMBINED CYCLIC AND SUSTAINED LOADING ON FLAW PROPAGATION CHARACTERISTICS; (5) DEVELOPMENT OF FRACTURE MECHANICS TECHNOLOGY TO MORE EFFECTIVELY DESCRIBE FLAW EXTENSION CHARACTERISTICS IN REGIONS OF SIGNIFICANT PLASTIC DEFORMATION; (6) DETERMINATION OF STRESS CORROSION THRESHOLD VALUES FOR SEVERAL ENVIRONMENTS AND MATERIAL COMBINATIONS; AND (7) EVALUATION OF PLANE STRAIN FRACTURE TOUGHNESS OF THICK SECTIONS.

RTOP NO. 124-08-43 TITLE: DYNAMICS OF ROTATING SPACE STATION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

THIS WORK WILL DEVELOP ANALYTICAL AND EXPERIMENTAL TECHNIQUES FOR PREDICTING THE DYNAMIC RESPONSE OF FLEXIBLE ROTATING SPACE STATIONS. COMPUTER SIMULATIONS OF THE STATION AND A COUNTERWEIGHT CONNECTED BY CABLES OR OTHER EXTENSIBLE MEMBERS WILL BE DEVELOPED AND USED TO DETERMINE THE THREE-DIMENSIONAL STATION DYNAMICS AND ELASTIC RESPONSE DURING EXTENSION, STEADY SPIN, AND RETRACTION. METHODS FOR EXPERIMENTAL EVALUATION OF SCALED AND FULL-SCALE ARTIFICIAL-GRAVITY STATION CONFIGURATIONS WILL BE DEFINED, AND LABORATORY TESTS WILL BE PERFORMED TO VERIFY THE ANALYTICAL AND SIMULATION RESULTS AND TO ESTABLISH GROUND TEST TECHNIQUES FOR THE FINAL SPACE STATION CONFIGURATION. SUBSEQUENT EFFORTS WILL BE DIRECTED AT EXTENSION OF THESE TECHNIQUES TO SPACE BASE CONFIGURATIONS. STRUCTURAL AND CONTROL DESIGN CRITERIA ASSOCIATED WITH THE ROTATING SPACE STATION DYNAMICS WILL ALSO BE IDENTIFIED.

RTOP NO. 124-09-21 TITLE: SPACE RADIATION SHIELDING AND DOSIMETRY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: VETTE, J. I. TEL. 301-982-2354
TECHNICAL SUMMARY

(A) TO PRODUCE AND MAINTAIN A TRAPPED RADIATION MODEL

ENVIRONMENT AND A SOLAR COSMIC RADIATION MODEL ENVIRONMENT IN FORMS USEFUL TO SPACE ENGINEERS AND SYSTEM PLANNERS WHICH BEST REFLECTS THE CURRENT UNDERSTANDING AND EMPIRICAL KNOWLEDGE OF THE PHENOMENA. (B) TO DISSEMINATE THIS ENVIRONMENT TO USERS IN NASA, OTHER GOVERNMENT AGENCIES, UNIVERSITIES, AND PRIVATE INDUSTRY.

RTOP NO. 124-09-21 TITLE: SPACE RADIATION SHIELDING AND DOSIMETRY
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

COMPILATION OF DATA AND METHODS TO CREATE AN INDUSTRY STANDARD FOR RADIATION CALCULATIONS; COMPLETION OF CURRENT WORK ON ELECTRON BREMSSTRAHLUNG AND CONTINUATION OF ELECTRON AND PROTON TRANSPORT PROCESSES WILL CONTINUE.

RTOP NO. 124-09-21 TITLE: SPACE RADIATION SHIELDING AND DOSIMETRY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: REETZ, A. TEL. 202-962-0067

TECHNICAL SUMMARY

RADIATION EFFECTS AND SHIELDING INFORMATION RELATED TO THE SPACE RADIATION ENVIRONMENT IS BEING COLLECTED, EVALUATED, AND DISSEMINATED TO THE SPACE VEHICLE DESIGNER AND ENGINEER. SPECIFICALLY, THE RADIATION EFFECTS INFORMATION CENTER (REIC) AT BATTELLE MEMORIAL INSTITUTE AND THE RADIATION SHIELDING INFORMATION CENTER (RSIC) AT OAK RIDGE NATIONAL LABORATORY WILL RECEIVE CONTINUED SUPPORT FOR WORK RELATED TO SPACE RADIATION EFFECTS AND SHIELDING. PREPARATION OF A RADIATION EFFECTS HANDBOOK AND A SPACE RADIATION SHIELDING HANDBOOK SUITABLE FOR USE BY SPACE VEHICLE DESIGNERS WAS INITIATED IN FY1969, AND WILL BE CONTINUED IN FY 1971.

RTOP NO. 124-09-21 TITLE: SPACE RADIATION SHIELDING AND DOSIMETRY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TWO FOLD: FIRST TO DEVELOP THE TECHNOLOGIES REQUIRED FOR THE PROTECTION OF MAN AND RADIATION-SENSITIVE COMPONENTS AND MATERIALS FROM UNDESIRABLE EFFECTS OF THE PARTICULATE SPACE RADIATION ENVIRONMENT. SPECIAL EMPHASIS WILL BE PLACED ON THE EXPERIMENTAL VERIFICATION OF THE SHIELDING EFFECTIVENESS OF COMPOSITE SPACECRAFT MATERIALS. SECOND, TO DEVELOP AND MAINTAIN, FOR USE OF LANGLEY PROJECTS, COMPUTER PROGRAMS THAT WILL DETERMINE THE RADIATION DOSES WITHIN A SPACECRAFT AS A FUNCTION OF ITS TRAJECTORY AND SHIELDING. TO MEET THESE OBJECTIVES, INVESTIGATIONS ARE BEING PERFORMED BOTH IN HOUSE AND ON CONTRACT THAT WILL PROVIDE MORE COMPLETE DATA FROM WHICH THE EFFECTIVENESS OF COMPOSITE SPACECRAFT MATERIALS AS RADIATION SHIELDS CAN BE EVALUATED.

TO DEVELOP THE COMPUTER PROGRAMS A COMPILATION OF THE MOST ACCURATE AND EFFICIENT PROGRAMS FROM SOURCES SUCH AS, OAK RIDGE NATIONAL

LABORATORIES AND CERN SWITZERLAND, WAS MADE. THE LATEST ENVIRONMENTAL INPUTS FROM NATIONAL SPACE SCIENCE DATA CENTER ARE USED.

RTOP NO. 124-09-22 TITLE: SPACE RADIATION EFFECTS LABORATORY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE FOR THE MANAGEMENT, OPERATION, AND MAINTENANCE OF THE SPACE RADIATION EFFECTS LABORATORY (SREL). THE LABORATORY IS USED JOINTLY BY SCIENTISTS AND ENGINEERS TO PERFORM RESEARCH IN BASIC PHYSICS, RADIOBIOLOGY, AND THE EFFECTS OF RADIATION ON MATERIALS, COMPONENTS, AND SYSTEMS PLANNED FOR USE IN SPACE. THE LABORATORY IS OPERATED BY THE COLLEGE OF WILLIAM AND MARY UNDER CONTRACT TO THE LANGLEY RESEARCH CENTER. THE OPERATING TIME IS SHARED EQUALLY BETWEEN EDUCATIONAL INSTITUTIONS AND GOVERNMENT AGENCIES.

RTOP NO. 124-09-23 TITLE: GROUND-BASED METEOR OBSERVATIONS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECT IS TO DETERMINE FROM GROUND-BASED RADAR AND OPTICAL OBSERVATIONS OF METEORS THE NATURE OF METEORIODS IN SPACE OVER THE RANGE OF MASS AND FLUX ANTICIPATED AS BEING A HAZZARD TO FUTURE SPACECRAFT. A MAJOR PORTION OF THE RESEARCH WILL BE ACCOMPLISHED BY CONTRACTING WITH THE SMITHSONIAN ASTROPHYSICAL OBSERVATORY WHO WILL OPERATE THE PATROLS AND ANALYZE MOST OF THE DATA. THIS RESEARCH WILL PROVIDE THE PHYSICAL AND ORBITAL CHARACTERISTICS OF METEORIODS LEADING TOWARDS THE DEFINITION OF THE METEOROID HAZARD.

RTOP NO. 124-09-23 TITLE: GROUND BASED METEOR OBSERVATION
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

MSFC HAS DEVELOPED A GROUND-BASED METEOR PROGRAM TO CLARIFY EXISTING UNCERTAINTIES IN THE METEOROID ENVIRONMENT. SUCH INFORMATION IS CRITICAL TO THE DESIGN CRITERIA OF LONG TERM ORBITING SPACECRAFT SUCH AS THE SPACE STATION. THE MSFC PROGRAM UTILIZES LOW LIGHT LEVEL TELEVISION AND PHOTOMETRIC SYSTEMS AS WELL AS THEORETICAL ANALYSES TO GAIN INFORMATION REGARDING THE NUMBER, MASS, LUMINOSITY, COLOR, HEIGHT, VELOCITY, AND ORBITAL PARAMETERS OF METEORS.

RTOP NO. 124-09-24 TITLE: METEOROID ENVIRONMENT MEASUREMENTS IN SPACE

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECT IS TO DEVELOP AND FLY THE SENSORS REQUIRED TO PROVIDE THE NEAR-EARTH AND INTERPLANETARY SPACE METEOROID PENETRATION DATA REQUIRED TO SUPPORT GROUND TESTS AND ANALYTICAL STUDY TO DEFINE THE METEOROID HAZARD FOR THE PROPER ENGINEERING DESIGN OF FUTURE SPACE VEHICLES. FLIGHT PENETRATION SENSORS ARE BEING DEVELOPED, BOTH IN-HOUSE AND ON CONTRACT FOR SECONDARY EXPERIMENTS ON SUCH SPACECRAFT AS PIONEER AND SATURN S-IVB. THIS RESEARCH WILL PROVIDE THE CROSSLINK DATA REQUIRED TO MOLD THE RESTRICTED GROUND TEST PENETRATION DATA, THE ANALYTICAL STUDIES, AND THE METEOR DATA INTO A METEOROID HAZARD MODEL CONSISTENT WITH PROPER ENGINEERING DESIGN.

RTOP NO. 124-09-24 TITLE: METEOROID/ASTEROID ENVIRONMENT MEASUREMENTS IN SPACE

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: FOSTER, J. V. TEL. 415-961-2267

TECHNICAL SUMMARY

EXPERIMENTS ARE BEING DEVELOPED FOR THE PIONEER F/G JUPITER MISSIONS TO DETERMINE THE METEOROID AND ASTEROID ENVIRONMENT IN THE REGION BETWEEN EARTH AND JUPITER AND TO PROVIDE REQUIRED DATA ON THE METEOROID AND ASTEROID HAZARD FOR THE PROPER ENGINEERING DESIGN OF SPACE VEHICLES ON LONG DURATION FLIGHTS TO THE OUTER PLANETS. ONE EXPERIMENT UTILIZES A REFLECTED LIGHT TECHNIQUE, AND HAS THE POTENTIAL OF YIELDING DATA ON SPEED, DIRECTION, (AND HENCE, PARTICLE ORBITS) AND PARTICLE SIZE OVER THE RANGE OF PARTICLE MASSES FROM 10 TO THE MINUS 8TH TO .001 GRAMS. A COMPLEMENTARY EXPERIMENT EMPLOYS THE PRESSURIZED CELL TECHNIQUE USED ON EXPLORERS 13, 16 AND 23, AND ON THE LUNAR ORBITERS, AND IS RESPONSIVE TO PARTICLE MASSES ON THE ORDER OF .0000001 GRAMS.

RTOP NO. 124-09-25 TITLE: METEOROID IMPACT AND PROTECTION

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

TWO AREAS OF RESEARCH ARE BEING CARRIED OUT UNDER THIS RTOP. ONE DEALING WITH THE INTERACTION OF MICRO-PARTICLES WITH MATERIALS, AND THE OTHER DEALING WITH IMPACTS ON SPACECRAFT WALLS. THE OBJECTIVES OF THE MICRO-PARTICLE WORK ARE TO MEASURE THE DAMAGE DONE TO SURFACES EXPOSED TO THE MICROMETEOROID ENVIRONMENT AND TO DEVELOP DETECTORS AND INSTRUMENTS SUITABLE FOR USE ON SATELLITES TO MEASURE THE MICROMETEOROID ENVIRONMENT. THE OBJECTIVES OF THE WORK WITH SPACECRAFT WALLS IS TO DEVELOP A CAPACITOR DISCHARGE GUN TO ACCELERATE PARTICLES AT METEORIC SPEEDS, AND THEN TO USE THE CAPACITOR DISCHARGE GUN AND LIGHT GAS GUNS TO RELATE IMPACT DAMAGE TO PROJECTILE PARAMETERS. IN ADDITION, THE EFFECT OF PROJECTILE SHAPE ON THE DAMAGE INFLICTED TO SINGLE-WALL STRUCTURES WILL BE STUDIED.

RTOP NO. 124-09-25 TITLE: METEOROID IMPACT AND PROTECTION
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DEVELOP THE UNDERSTANDING OF HYPERVELOCITY IMPACT REQUIRED TO DESIGN FUTURE SPACECRAFT HAVING ADEQUATE METEOROID PROTECTION. EFFECTS OF MATERIAL, PROJECTILE DENSITY, SIZE, AND SHAPE, AND PROJECTILE VELOCITY ON PENETRATION AND CRATERING PHENOMENA WILL BE STUDIED EXPERIMENTALLY AND ANALYTICALLY. IMPROVEMENTS IN LAUNCHER PERFORMANCE RESULTING FROM HIGH-EXPLOSIVE DRIVER DEVELOPMENT CARRIED OUT UNDER RTOP 124-09-25 WILL BE EXPLOITED TO THE MAXIMUM POSSIBLE EXTENT. IMPROVEMENTS IN ELECTROSTATIC ACCELERATOR PERFORMANCE WILL ALSO BE SOUGHT. RESULTS OF THIS WORK WILL BE NEEDED FOR THE DESIGN OF METEOROID BUMPERS FOR SPACECRAFT AND PARTICULARLY FOR SPACECRAFT TRAVERSING THE ASTROID BELT.

RTOP NO. 124-09-26 TITLE: SPACE VEHICLE THERMAL CONTROL
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: FOSTER, J. V. TEL. 415-961-2267
TECHNICAL SUMMARY

THE STANDARD HEAT PIPE HAS A FIXED, HIGH CONDUCTANCE AND MUST, THEREFORE, BE DESIGNED FOR GIVEN HEAT SOURCE AND SINK CONDITIONS. DEVIATION FROM THESE CONDITIONS RESULTS IN THE OVERCOOLING OR OVERHEATING OF THE HEAT SOURCE. A HEAT PIPE DESIGNED, HOWEVER, TO VARY ITS EFFECTIVE CONDUCTANCE IN RESPONSE TO CHANGING CONDITIONS CAN BE USED TO CONTROL THE SOURCE AT A NEAR-CONSTANT TEMPERATURE. CONSEQUENTLY, DETAILED STUDIES ARE MAPPING THE PERFORMANCE OF SEVERAL TECHNIQUES FOR VARYING PIPE CONDUCTANCE. ADDITIONALLY, A FUNDAMENTAL UNDERSTANDING OF THE INTERACTION BETWEEN NON-CONDENSING GAS AND WORKING FLUID IS BEING SOUGHT. THE OVERALL OBJECTIVE IS TO PROVIDE THE THERMAL DESIGNER WITH A SIMPLIFIED ONE-WAY HEAT PIPE TO ACT AS A THERMAL DIODE, A VARIETY OF VARIABLE CONDUCTANCE HEAT PIPES FOR CLOSE TEMPERATURE CONTROL, AND A HANDBOOK WITH AVAILABLE COMPUTER ROUTINES AS AN AID IN UTILIZING HEAT PIPE TECHNOLOGY. IDENTIFICATION OF PARAMETERS WHICH INFLUENCE THE STABILITY OF THERMAL-CONTROL COATINGS IS BEING SOUGHT. BECAUSE ALL SPACECRAFT HAVE EXTERIOR SURFACES WHICH MUST REACT WITH THE SPACE-RADIATION AND THERMAL ENVIRONMENT, SPACE-SIMULATION EXPOSURE TECHNIQUES MUST BE DEVELOPED TO PROVIDE REALISTIC LABORATORY EVALUATIONS. LABORATORY STUDIES OF THE INFLUENCE OF ELECTROMAGNETIC AND PARTICULATE RADIATION AND SURFACE TEMPERATURE IN A HIGH-VACUUM ENVIRONMENT ARE BEING CONDUCTED. RESULTS WILL BE COMPARED WITH FLIGHT-EXPERIMENT DATA WHERE MATERIALS RECOVERED FROM THE SURVEYOR III SPACECRAFT WILL BE EXAMINED FOR DEGRADATION BY THE LUNAR ENVIRONMENT IN ORDER TO CHARACTERIZE THEIR OPTICAL AND THERMAL CONTROL PROPERTIES AFTER LONG-TERM EXPOSURE.

RTOP NO. 124-09-26 TITLE: SPACE THERMAL CONTROL DEVELOPMENT
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

SPACE THERMAL CONTROL IS A VITAL AREA OF NASA'S R&D PROGRAM BECAUSE OF ENVIRONMENTAL TEMPERATURE REQUIREMENTS NECESSARY FOR MANNED FLIGHTS AND FOR EQUIPMENT OPERATION. THE FIELD OF THERMAL CONTROL OF SPACECRAFT IS BROAD AND INCLUDES SUCH AREAS AS COATINGS, HEAT PIPES, FUSIBLE MATERIALS, FLUID LOOPS AND RADIATING FINS INTERFACE THERMAL CONDUCTANCE. THIS RTOP IS DIRECTED PRIMARILY AT THERMAL CONTROL BY FUSIBLE MATERIALS. SPECTRAL REFLECTANCE, AND INFRARED DETECTION UNDER CRYOGENIC CONDITIONING IS ALSO INCLUDED. FUSIBLE MATERIALS IDENTIFICATION, DEVELOPMENT AND RESEARCH IN PHASE CHANGE OPERATION IN THE SPACE ENVIRONMENT WILL BE CONTINUED. STUDIES OF CLOSE SPACING ON THE RADIATIVE TRANSPORT OF ENERGY BETWEEN METAL OR DIELECTRIC PLATES AT TEMPERATURES APPROACHING THAT OF LIQUID HELIUM WILL ALSO BE CONTINUED.

RTOP NO. 124-09-26 TITLE: SPACE VEHICLE THERMAL CONTROL
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: SCHACH, M. TEL. 301-982-5115
TECHNICAL SUMMARY

THIS PROPOSAL IS FOR IMPROVING THE STATE-OF-THE-ART IN THE TEMPERATURE CONTROL OF SPACECRAFT. CURRENT APPROACHES ARE (1) TO IDENTIFY MECHANISMS RESPONSIBLE FOR COATING DEGRADATION IN THE SPACE ENVIRONMENTS IN ORDER TO DEVELOP IMPROVED COATINGS; (2) TO DEVELOP IMPROVED LABORATORY, PORTABLE, AND IN-FLIGHT DEVICES FOR MEASURING THE THERMAL RADIATIVE PROPERTIES OF SURFACE COATINGS AND FINISHES; (3) TO DEVELOP ADVANCED COMPUTER PROGRAMS FOR SPACECRAFT THERMAL ANALYSIS; AND (4) TO MAKE IMPROVEMENTS IN HEAT PIPE DESIGN AND FABRICATION TECHNIQUES.

RTOP NO. 124-09-26 TITLE: SPACE VEHICLE THERMAL CONTROL
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

IN THE SPACE VEHICLE THERMAL CONTROL AREA A COMPREHENSIVE EXPERIMENTAL AND THEORETICAL PROGRAM, BOTH IN-HOUSE AND ON CONTRACT, IS IN PROGRESS TO DEFINE, STUDY, AND DEVELOP SOLUTIONS TO THERMAL CONTROL ADVANCED TECHNOLOGY PROBLEMS ASSOCIATED WITH UNMANNED SPACE VEHICLES. A SPACE ENVIRONMENTAL EFFECTS SYSTEM TO STUDY THE EFFECTS OF VACUUM, TEMPERATURE, ULTRAVIOLET RADIATION, AND LOW ENERGY ELECTRONS AND PROTONS ON THE THERMAL RADIATION PROPERTIES OF SPACECRAFT THERMAL CONTROL COATINGS WILL BE OPERATIONAL. DEVELOPMENT OF THERMAL CONTROL COATINGS WILL CONTINUE WITH EMPHASIS ON POLYMERIC COATING MATERIALS. RESEARCH IN ADVANCED THERMAL CONTROL METHODS (E.G., PASSIVE ENCLOSURE) AND THERMAL MODELING TECHNIQUES WILL CONTINUE. THIS RESEARCH IS DIRECTED AT PROVIDING THE TECHNOLOGY FOR FUTURE LONG DURATION INTERPLANETARY MISSIONS AND LARGE ORBITING ASTRONOMICAL TELESCOPES.

RTOP NO. 124-09-26 TITLE:
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE THE TECHNOLOGY NECESSARY TO INSURE THAT ADEQUATE TEMPERATURE CONTROL OF THE SPACECRAFT PLANNED FOR THE NEW MISSIONS NOW BEING CONSIDERED CAN BE ACCOMPLISHED. THESE MISSIONS, TRAVELING IN TOWARDS THE SUN, AND OUTWARD AWAY FROM THE SUN TO THE OUTER PLANETS, POSE SOME NEW AND SEVERE THERMAL PROBLEMS. THIS TECHNOLOGY WILL BE PROVIDED BY A PROGRAM OF RESEARCH IN FOUR BROAD AREAS: (1) DEFINITION OF THERMAL CONTROL REQUIREMENTS AND IDENTIFICATION OF NECESSARY ADVANCES. (2) DEVELOPMENT OF ADVANCED ANALYTICAL AND DESIGN TECHNIQUES THAT WILL ALLOW BETTER PREDICTION OF SPACECRAFT HEAT TRANSFER. (3) DEVELOPMENT OF SELECTED TEMPERATURE CONTROL DEVICES WHICH CAN BE USED FOR MORE EFFECTIVE SPACECRAFT TEMPERATURE CONTROL DESIGN. THESE DEVICES WILL TYPICALLY BE AIMED AT CONTROLLING OR MODIFYING THE FLOW OF HEAT BETWEEN VARIOUS PARTS OF THE SPACECRAFT, BETWEEN THE SPACECRAFT AND SPACE, OR TO MEASURE SOME PARTICULAR HEAT TRANSFER PARAMETER. (4) IMPROVEMENTS IN THE TECHNOLOGY OF MATERIALS SELECTION, UTILIZATION AND PERFORMANCE OF TEMPERATURE CONTROL INSULATIONS, DEVICES, AND COATING SYSTEMS.

RTOP NO. 124-09-26 TITLE: SPACE VEHICLE THERMAL CONTROL
ORGANIZATION: NASA HEADQUARTERS
MONITOR: MOOK, C. TEL. 202-962-4738
TECHNICAL SUMMARY

THIS PROPOSAL COVERS A BROAD PROGRAM OF IDENTIFICATION, EXTRACTION, EVALUATION, AND SYSTEMIZATION OF DATA ON THE THERMAL RADIATIVE PROPERTIES OF SOLID MATERIALS OF TECHNOLOGICAL INTEREST TO NASA AND IN PARTICULAR THOSE INVOLVED IN THE THERMAL DESIGN OF SPACECRAFT. A LARGE QUANTITY OF DATA IS BEING GENERATED ON THE REFLECTANCE AND EMITTANCE OF THERMAL RADIATIVE ENERGY BY SOLID MATERIALS AT VARIOUS WAVELENGTHS AND THIS CONTINUING EFFORT ATTEMPTS TO BRING ALL REPORTED DATA OF SIGNIFICANCE INTO PROPER VIEW AND PERSPECTIVE PERMITTING THERMAL DESIGNERS ACCESS TO OTHERWISE ELUSIVE OR UNAVAILABLE DATA, AND WHERE POSSIBLE, FORESTALL USELESS DUPLICATION OF MEASUREMENTS.

RTOP NO. 124-09-26 TITLE: SPACE VEHICLE THERMAL CONTROL
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: MARK, H. TEL. 216-433-4000
TECHNICAL SUMMARY

THE OBJECTIVE IS TO SOLVE THE PROBLEMS OF HEAT TRANSFER AT BOUNDARIES IN A SPACE ENVIRONMENT. THE RESEARCH INCLUDES ENERGY TRANSFER (1) AT SOLID-SOLID INTERFACES SUCH AS BOLTED JOINTS, (2) OF CRITICAL SURFACES SHIELDING CRYOPROPELLANT TANKAGE, WHICH ARE SUBJECTED TO THE DEPOSITION OF CONDENSING GASES, (3) OF RADIATOR SURFACES, (4) THROUGH OPTICALLY CLEAR SURFACES SUBJECTED TO THE SOLAR WIND, MICROPARTICLE IMPACTION, AND ULTRAVIOLET EXPOSURE. IN ADDITION, THE EFFECTS ON SPACE VEHICLE SURFACES OF FIRING CHEMICAL

ROCKETS FOR MANEUVERING OR DOCKING IN THE VICINITY OF ANOTHER SPACE VEHICLE WILL BE DETERMINED. TO IMPROVE SPACE ENVIRONMENT SIMULATION, ABSOLUTE STANDARDS FOR RADIONETRIC AND VACUUM MEASURING INSTRUMENTS.

RTOP NO. 124-09-27 TITLE: THERMAL/VACUUM TESTING TECHNOLOGY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS PROPOSED RTOP ARE TO (1) DEVELOP METHODS FOR MEASURING THERMAL/VACUUM EFFECTS ON SPACE VEHICLE MATERIALS, (2) DEVELOP ACCELERATED TESTING TECHNIQUES FOR THERMAL VACUUM MEASUREMENTS, AND (3) DEVELOP METHODS FOR VACUUM MEASUREMENTS AND STANDARDS FOR VACUUM GAUGE CALIBRATIONS. THE OBJECTIVE WILL BE ACCOMPLISHED WITH A BALANCED PROGRAM OF IN-HOUSE RESEARCH SUPPORTED BY CONTRACTS AS REQUIRED. EXPERIMENTAL METHODS FOR MEASURING THERMAL/VACUUM EFFECTS ON THE MECHANICAL AND THERMAL PROPERTIES ARE BEING DEVELOPED AND USED TO IDENTIFY VACUUM DEGRADATION PHENOMENA IN GENERAL CLASSES OF MATERIALS. WHEN THE DEGRADATION PHENOMENA IS ELUCIDATED, THE PARAMETERS FOR ACCELERATING THE PHENOMENA WILL BE SELECTED. VACUUM MEASUREMENT CAPABILITY AND STANDARDS FOR VACUUM GAUGE CALIBRATION ARE NEEDED TO SUPPORT THE MEASUREMENT PROGRAMS. THE RESULTS OF THIS RTOP WILL PROVIDE THE TECHNOLOGY NEEDED FOR THERMAL/VACUUM TESTING OF SPACE VEHICLE MATERIALS.

RTOP NO. 124-09-27 TITLE: THERMAL/VACUUM TESTING TECHNOLOGY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: KRUGER, R. TEL. 301-982-5034
TECHNICAL SUMMARY

THIS RTOP IS BASICALLY INTENDED TO IMPROVE SPACE SIMULATION TEST TECHNIQUES. THIS INCLUDES IMPROVING ABILITIES FOR SIMULATING THE SPACE VACUUM ENVIRONMENT, THE EXTRATERRESTRIAL SOLAR ENVIRONMENT, AND THE PLANETARY ALBEDO AND INFRARED EMITTED ENERGIES. CONCOMITANT WITH THESE OBJECTIVES IS THE IMPROVEMENT OF OUR KNOWLEDGE OF THE ACTUAL ENVIRONMENT AND THE EFFECTS OF THIS ENVIRONMENT (WITH DUE REGARD FOR THE REQUIREMENTS FOR SUCH PARAMETERS AS SOLAR SPECTRAL MATCH AND VACUUM LEVEL), AND THE DEVELOPMENT OF MEANS FOR MEASURING THIS ENVIRONMENT, DEFINING ITS SIMILARITY TO THE REAL ENVIRONMENT, AND EXTRAPOLATING RESULTS FROM TEST OPERATIONS TO SPACE PERFORMANCE. THE WORK IS INTENDED TO INCREASE THE ASSURANCE OF SUCCESSFUL SPACECRAFT MISSIONS BY IMPROVING TEST TECHNIQUES. CURRENT APPROACHES INCLUDE BETTER DEFINITION OF THE SOLAR SPECTRAL IRRADIANCE, THE DEVELOPMENT OF LONG-TERM, CLEAN, VACUUM SYSTEMS CAPABLE OF UNATTENDED OPERATION, THE INVESTIGATION OF VARIOUS TYPES OF LIGHT SOURCES FOR USE AS RADIATION SIMULATORS, INVESTIGATION OF CONTAMINATION PHENOMENA ASSOCIATED WITH VACUUM TESTING, INSTRUMENTS FOR IN-TEST MONITORING, AND IMPROVED ANALYTICAL TECHNIQUES FOR UTILIZING THE INFORMATION ARISING FROM TESTS.

RTOP NO. 124-09-27 TITLE: SPACE SIMULATION TESTING TECHNOLOGY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

THE OBJECTIVE IS TO ADVANCE THE STATE OF THE ART IN SPACE ENVIRONMENT SIMULATION TECHNOLOGY. THE THREE AREAS OF THIS TECHNOLOGY WHICH WILL BE ATTACKED ARE: 1) SOLAR SIMULATION FOR THERMAL VACUUM TESTING OF SPACECRAFT; 2) SPACE MOLECULAR FLUX SIMULATION FOR COLDWELDING TESTS OF SPACECRAFT MECHANISMS; AND 3) COMBINATION OF RADIATION AND MOLECULAR FLUX SIMULATION. BETTER SOLAR SIMULATION WILL BE SOUGHT INCREASING THE BRIGHTNESS OF LIGHT SOURCES WHICH WOULD ALLOW ANY OF SEVERAL PERFORMANCE CHARACTERISTICS TO BE IMPROVED. MOLECULAR FLUX STUDIES WILL INCLUDE CONTINUED EVALUATION OF COLDWELDING VACUUM ENVIRONMENTS THROUGH EXPERIMENTS WITH A FRICTION TEST MODULE FOR WHICH IN-SPACE CHARACTERISTICS ARE AVAILABLE. THE COMBINED ENVIRONMENT WORK CONSISTS OF THE EVALUATION OF THE USEFULNESS OF INCLUDING A COMBINATION OF SOLAR PHOTON AND SOLAR WIND GENERATORS IN THE MOLSINK.

RTOP NO. 124-09-28 TITLE: OPTICAL CONTAMINATION
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

IN ORDER TO CONTINUE THE OPTICAL CONTAMINATION EFFECTS WORK AT MSFC AND TO PROVIDE THE NECESSARY GROUND SUPPORT DATA FOR FLIGHT EXPERIMENTS, IT IS ESSENTIAL THAT CERTAIN LABORATORY EQUIPMENT BE ADDED TO OUR EXISTING FACILITIES AND THAT SPECIFIC CONTRACTED STUDIES BE INITIATED AT THIS TIME. EQUIPMENT PURCHASES WILL BE IN THE NATURE OF ONE-TIME CAPITAL EXPENDITURES, WHEREAS THE CONTRACTED STUDIES ARE PREPARATORY TO ADVANCED FLIGHT MONITORING SYSTEMS FOR SKYLAB II AND THE SPACE STATION OR COMPLEMENT THOSE EFFORTS. THIS PROGRAM IS PART OF THE OVERALL MSFC PROGRAM IN THIS AREA, AS IT IS VITAL TO THE DETERMINATION OF THE DEGRADATION OF THE OPTICAL PROPERTIES OF ASTRONOMICAL INSTRUMENTS, THERMAL CONTROL SURFACES, AND OTHER CRITICAL OPTICAL SURFACES TO BE USED ON MANNED SPACECRAFT.

RTOP NO. 124-09-30 TITLE: METEOROID IMPACT AND PROTECTION FOR SPACE STATION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS RESEARCH ARE TO DEVELOP ANALYTICAL PROCEDURES THAT WILL PREDICT THE METEOROID HAZARD TO SPACE VEHICLES, TO PROVIDE THE ANALYTICAL MEANS FOR OPTIMIZING THE PROTECTION FROM SUCH A HAZARD. THESE OBJECTIVES WILL BE MET BY COMBINED EXPERIMENTAL AND THEORETICAL INVESTIGATIONS ABOUT THE BEHAVIOR OF MATERIALS AND STRUCTURAL WALL CONFIGURATIONS UNDER METEOROID IMPACT. THE RESULT OF THESE STUDIES WILL PROVIDE A MUCH NEEDED SOUND BASIS FOR DESIGN OF LIGHTWEIGHT SHIELDING AGAINST THE HAZARDS OF METEOROIDS.

RTOP NO. 124-09-30 TITLE: METEOROID IMPACT AND PROTECTION (SPACE STATION)

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

STUDIES AIMED AT MAXIMIZING THE EFFECTIVENESS OF MULTIPLE-WALL STRUCTURES IN PROVIDING METEOROID PROTECTION OF SPACE STATION/SPACE BASE ARE IN PROGRESS. STRESS CONCENTRATIONS IN PANELS, RESULTING FROM PARTIAL-PENETRATION IMPACTS, ARE BEING STUDIED TO DETERMINE THE DEGRADATION IN STRUCTURAL INTEGRITY AND EFFICIENCY, AND THE IMPLICATIONS WITH RESPECT TO DESIGN CRITERIA. HIGH-EXPLOSIVE DRIVER TECHNIQUES ARE BEING DEVELOPED FOR ACCELERATING LABORATORY PROJECTILES TO METEORIC SPEEDS. THE OVERALL OBJECTIVE IS TO DEVELOP COMPREHENSIVE DESIGN CRITERIA WHICH CAN BE USED BOTH TO DESIGN IMPACT-RESISTANT STRUCTURES FOR PROTECTION OF THE SPACE STATION/BASE, AND TO ASSESS THE LONG-TERM PERFORMANCE OF IMPACTED STRUCTURAL ELEMENTS.

RTOP NO. 124-09-31 TITLE: SPACE VEHICLE THERMAL CONTROL (SPACE STATION)

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

AS A CONTINUATION OF OUR WORK IN THE THERMAL CONTROL FIELD, OUR EFFORTS WILL BE DIRECTED TOWARD SEVERAL METHODS OF IMPROVING NASA'S CAPABILITIES OF CONTROLLING SPACECRAFT TEMPERATURES. ONE EFFORT WILL BE DIRECTED TOWARD IMPROVEMENT OF THE WHITE PAINTS AND THEIR RELIABILITY FOR EXTENDED MISSION REQUIREMENTS. WHILE MAINTAINING THE 0.9 EPSILON REQUIRED IN THE PRESENT THERMAL DESIGNS FOR SPACE STATION, THE DELTA ZETA MUST BE A MINIMUM TO OBTAIN THE REQUIRED TOTAL LIFE OR THE LEAST EVA REQUIRED TO RESTORE THE THERMAL-CONTROL SURFACES. THIS IS BEING DONE BY IMPROVING THE BINDERS AND PIGMENTS, AND TECHNIQUES OF PROTECTION OF THE RESULTANT COATING TO ITS EVENTUAL MISSION REQUIREMENT. IN ORDER TO PROVIDE NECESSARY BACK-GROUND KNOWLEDGE FOR THIS DEVELOPMENT EFFORT, STUDIES OF THE DEGRADATION OF THERMAL CONTROL COATINGS WILL CONTINUE AND A SPECIAL EFFORT WILL BE CONDUCTED IN THE STUDY OF THERMAL PROPERTIES OF COATINGS AND THEIR SUBSTRATES AT CRYOGENIC TEMPERATURES. ADDITIONALLY, THIS EFFORT WILL INCLUDE THE STUDY OF WASTE HEAT UTILIZATION; AND DESIGN GUIDELINES FOR THE USE OF HEAT PIPES WILL BE ESTABLISHED.

RTOP NO. 124-09-31 TITLE: SPACE STATION - SPACE VEHICLE THERMAL CONTROL

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: GREENSHIELDS, D. TEL. 713-483-3676

TECHNICAL SUMMARY

THERMAL CONTROL REQUIREMENTS FOR THE SPACE STATION ARE DISTINCTLY DIFFERENT FROM THOSE OF PREVIOUS SPACECRAFT DESIGNS. THE UNIQUE REQUIREMENTS PRESENT DESIGN PROBLEMS IN THERMAL CONTROL WHICH MUST BE SUBJECTED TO ANALYSIS WITH A VIEW TOWARD DEVELOPMENT OF

OPTIMAL DESIGN OF THE THERMAL CONTROL SYSTEMS. ADVANCED TECHNIQUES OF THERMAL MATHEMATICAL MODELING MUST BE DEVELOPED, SINCE THE LARGE SIZE AND COMPLEXITY MAKE PRESENT TECHNIQUES INADEQUATE. IN ADDITION, ADVANCED THERMAL CONTROL COMPONENT CONCEPTS MUST BE DEVELOPED FOR USE IN IMPLEMENTATION OF THE OPTIMUM DESIGN APPROACHES. HEAT PIPES PROVIDE THE POTENTIAL FOR LONG, TROUBLE-FREE HEAT TRANSPORT AT LOW WEIGHTS PARTICULARLY FOR LARGE SPACE STATIONS AND EQUIPMENT COOLING APPLICATIONS. HOWEVER, THE STATE-OF-THE-ART IN THESE NEW SYSTEMS HAS ADVANCED RAPIDLY, AND NO CONSISTANT APPROACH TO DEFINING CONFIGURATIONS FOR VARIOUS USE OPTIONS EXISTS. UNDER THIS PROGRAM, DESIGN PROCEDURES, BOTH IN PARAMETRIC AND COMPUTER PROGRAM FORM, WILL BE DEVELOPED. THE DEVELOPMENT OF IMPROVED DESIGN TECHNIQUES FOR HEAT REJECTION SYSTEMS WILL BE PURSUED THROUGH AUTOMATION OF CALCULATIONAL PROCEDURES FOR A WIDE RANGE OF CONFIGURATION OPTIONS. FEASIBLE ALTERNATE APPROACHES TO FULL-SCALE THERMAL DESIGN VERIFICATION TESTING WILL BE DEVELOPED, AND EVALUATED FOR APPLICATION FOR SPACE STATION DESIGN. UNDER THIS PROGRAM, THERMAL SCALING AND MODULAR TESTING OF HEAT REJECTION SYSTEM USING FLUID HEAT TRANSPORT LOOPS WILL BE INITIATED AS AN ADDITION TO ON GOING PASSIVE SYSTEM THERMAL SCALE MODELING PROGRAM.

RTOP NO. 124-12-06 TITLE: SPACE VEHICLE DESIGN CRITERIA
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: MILLS, S. A. TEL. 301-982-4246
TECHNICAL SUMMARY

TO DEVELOP AND PUBLISH (1) NASA DESIGN CRITERIA FOR TERRESTRIAL AND EXTRATERRESTRIAL ENVIRONMENTS AND (2) GSFC ENVIRONMENTAL TEST SPECIFICATIONS. FOR THIS TASK, WE ASSESS DATA FROM THREE SOURCES: SPACE AND TERRESTRIAL RESEARCH, SPACECRAFT VEHICLE OPERATIONAL PERFORMANCE, AND ENVIRONMENTAL TEST EXPERIENCE. THE OBJECTIVE, WHICH IS TO IMPROVE DESIGN AND PERFORMANCE OF SPACE SYSTEMS, IS CARRIED OUT IN THREE COMPLEMENTARY WAYS: (1) DEVELOPMENT OF SOME 30 NASA DESIGN CRITERIA MONOGRAPHS, EACH OF WHICH PRESENTS ENGINEERING DESCRIPTION AND/OR A MODEL OF AN ENVIRONMENT WHICH CAN AFFECT THE DESIGN OF SPACE VEHICLES AND THE PLANNING OF SPACE MISSIONS. AS LEAD CENTER, GSFC INITIATES, COORDINATES, AND REVIEWS EFFORTS OF PARTICIPATING NASA CENTERS, AND CONTRIBUTING SCIENTISTS, ENGINEERS, AND CONTRACTORS. (2) FORMULATION OF GSFC GENERAL SPECIFICATIONS FOR TESTING SPACECRAFT AND SOUNDING ROCKET PAYLOADS. REVISIONS ARE MADE IN RESPONSE TO NEW ENVIRONMENTAL KNOWLEDGE OR WHEN NASA ADOPTS NEW LAUNCH VEHICLES. (3) THE EXPERIENCE AND PERFORMANCE (PEP) EFFORT COMPARES ACTUAL SPACECRAFT OPERATIONAL RESULTS WITH PRIOR ENVIRONMENTAL TESTS. THE OBJECT IS TO IMPROVE THE TEST PROGRAM AND ATTAIN MAXIMUM RELIABILITY IN SPACE PERFORMANCE.

RTOP NO. 124-12-07 TITLE: SPACE VEHICLE DESIGN CRITERIA
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

PART A - THE OBJECTIVE OF THIS WORK IS TO PREPARE A SET OF

ENVIRONMENT DESIGN CRITERIA FOR THE PLANETS REQUIRED FOR SPACE VEHICLE DESIGN, AND TO SUPPORT AT A LEVEL OF APPROXIMATELY ONE-MAN-YEAR THE SPACE VEHICLE DESIGN CRITERIA PROGRAM IN THE AREAS OF STRUCTURES, GUIDANCE AND CONTROL, CHEMICAL PROPULSION AND ENVIRONMENTS. THIS EFFORT IS IN DIRECT SUPPORT OF THE NASA SPACE VEHICLE DESIGN CRITERIA PROGRAM. THE CURRENT EFFORT IS DIRECTED TOWARD COMPLETING SPACE VEHICLE DESIGN CRITERIA DOCUMENTS FOR THE MARS SURFACE AND THE PLANET JUPITER, CONTINUING THE EFFORT TO DEVELOP A DESIGN CRITERIA DOCUMENT FOR THE PLANET MERCURY AND INITIATING THE DEVELOPMENT OF A DESIGN CRITERIA DOCUMENT FOR THE PLANET SATURN DURING FY'70. TOGETHER WITH KNOWLEDGEABLE SCIENTISTS, ENGINEERS, AND DESIGNERS IMPORTANT ENVIRONMENTAL PARAMETERS WILL BE IDENTIFIED. BASED ON THE CURRENT STATE-OF-THE-ART KNOWLEDGE OF THE SPECIFIED ENVIRONMENT, ENGINEERING DESCRIPTIONS, AND/OR MODELS WILL BE DEVELOPED AND SPACE VEHICLE DESIGN CRITERIA FOR THE IMPORTANT ENVIRONMENTAL PARAMETERS ESTABLISHED. AN ENVIRONMENTAL DESIGN CRITERIA DOCUMENT WILL BE COMPOSED, EDITED, AND WRITTEN IN THE ESTABLISHED STYLE. THE DOCUMENTS PASS THROUGH THE REGULAR REVIEW CYCLE, AND THEN THE FINAL DRAFT IS SENT TO GSFC FOR PUBLICATION. PART B - THE GENERAL OBJECTIVE OF PART B IS TO PLAN, ESTABLISH AND EXECUTE A PROGRAM FOR THE PREPARATION OF SPACE VEHICLE DESIGN CRITERIA IN THE AREA OF GUIDANCE AND CONTROL. THE SPECIFIC NEAR TERM OBJECTIVES ARE: TO DEVELOP AND INITIATE A PLAN FOR CONTINUATION OF THE GUIDANCE AND CONTROL DESIGN CRITERIA PROGRAM; TO COMPLETE THE MONOGRAPHS INITIATED AT THE ELECTRONICS RESEARCH CENTER.

RTOP NO. 124-12-08 TITLE: SPACE VEHICLE DESIGN CRITERIA
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

TO DEVELOP AND DOCUMENT FOR USE OF NASA FLIGHT PROGRAMS AND THEIR CONTRACTORS SOUNDLY-CONCEIVED AND AUTHORITATIVE GUIDELINES FOR THE DESIGN OF FLIGHT-WORTHY SPACE VEHICLE STRUCTURE. THE GUIDELINES SHOULD BE BASED ON THE CURRENT STATE OF THE ART USING THE MOST APPROPRIATE AND KNOWLEDGEABLE PEOPLE FROM GOVERNMENT, INDUSTRY AND UNIVERSITIES. RESULTS ARE TO BE SUMMARIZED AND PUBLISHED IN DESIGN CRITERIA MONOGRAPHS (SP-8000 SERIES) EACH TREATING A STRUCTURAL PROBLEM OF CONCERN TO NASA FLIGHT PROGRAMS OR THEIR CONTRACTORS. TO PARTICIPATE ACTIVELY IN THE APPLICATION OF THESE RESULTS AND INDUSTRY EXPERIENCE TO EMERGING AND ON-GOING FLIGHT PROGRAMS AND TO FOCUS ATTENTION ON TECHNOLOGY GAPS AND CRITICAL ISSUES THAT REQUIRE EXAMINATION. AS LEAD CENTER LANGLEY ESTABLISHES SUBJECTS AND PRIORITIES AND ARRANGES FOR AND COORDINATES PARTICIPATION OF TECHNICAL SPECIALISTS FROM THE NASA, INDUSTRY, AND ELSEWHERE TO ASSIST IN THE ASSESSMENT OF AVAILABLE INFORMATION AND IN THE PREPARATION, REVIEW, EVALUATION, AND UPDATING OF MONOGRAPHS. IN ADDITION THE CENTER ARRANGES FOR REVIEW OF MONOGRAPHS PREPARED BY OTHER NASA CENTERS. THE SPACE VEHICLE DESIGN CRITERIA OFFICE (SVDCO), REPORTING TO THE ASSISTANT DIRECTOR FOR FLIGHT PROJECTS, COORDINATES THIS ACTIVITY FOR LANGLEY, WORKING WITH DESIGNATED CONTACTS AT OTHER NASA CENTERS AND JPL AND WITH NASA TECHNICAL ADVISORS FAMILIAR IN THE SUBJECT AREA. A LANGLEY DESIGN CRITERIA

STEERING COMMITTEE, REPORTING TO THE DIRECTOR, ADVISES SVDCO ON
SUBJECT PRIORITIES AND RECOMMENDS ON PROGRAM POLICY.

RTOP NO. 124-12-09 TITLE: DESIGN CRITERIA
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: DOUGLASS, H. W. TEL. 216-433-6915
TECHNICAL SUMMARY

THIS PROGRAM IS DIRECTED AT THE DEVELOPMENT AND PUBLICATION OF
UNIFIED DESIGN CRITERIA FOR CHEMICAL ROCKET PROPULSION, INCLUDING
BOTH LIQUID AND SOLID PROPELLANTS. THE PUBLICATIONS ARE TO BE
COMPLETE AND AUTHORITATIVE DOCUMENTS FOR USE BY DESIGNERS AND PROJECT
MANAGERS IN DESIGNING FUTURE SPACE PROPULSION SYSTEMS AND IN
IMPROVING PRESENT SYSTEMS. THE DOCUMENTS WILL BE IN THE FORM OF
DESIGN CRITERIA MONOGRAPHS RELATING TO PARTICULAR PROPULSION
COMPONENTS, SUBSYSTEMS, OR SYSTEM. EACH MONOGRAPH WILL DISCUSS THE
RELATED STATE OF THE ART, ESTABLISH DESIGN CRITERIA, PRESENT
RECOMMENDED PRACTICES, AND REFERENCE LITERATURE USED AS THE BASIS FOR
THE CRITERIA. THE MONOGRAPHS ARE BEING WRITTEN BY CONTRACTORS
SELECTED BY THE NASA ON THE BASIS OF COMPETENCE, ACKNOWLEDGED
LEADERSHIP IN THEIR FIELDS, AND ABILITY TO ESTABLISH AUTHORITATIVE
AND RELIABLE DESIGN CRITERIA. THE CONTRACTOR ALSO PREPARES A DOSSIER
CONTAINING THE MATERIAL UPON WHICH THE MONOGRAPH IS BASED, FOR
RETENTION BY NASA FOR REFERENCE. ACCOMPLISHMENTS ON THE DESIGN
CRITERIA PROGRAM TO DATE: 1. CONTRACTS AWARDED 53 2. EDITORIAL
DRAFTS IN PREPARATION 26 3. TECHNICAL EDITORIAL MEETINGS HELD 17 4.
TRANSMITTAL COPIES SUBMITTED 6 5. REVIEW DRAFTS TO HEADQUARTERS 6 6.
MONOGRAPHS PUBLISHED BY HEADQUARTERS 0

RTOP NO. 124-12-10 TITLE: SPACE VEHICLE DESIGN CRITERIA
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: COUR-PALAIS, B. G. TEL. 713-483-5841
TECHNICAL SUMMARY

TO DATE A SPACE VEHICLE DESIGN CRITERIA MONOGRAPH ENTITLED
METEOROID ENVIRONMENT MODEL 1969 (NEAR EARTH TO CISLUNAR), SP-8013
HAS BEEN COMPLETED, ISSUED, AND IS IN USE BY MSC AND MSFC. AN
INTERPLANETARY METEOROID ENVIRONMENT MODEL HAS BEEN FINALIZED AND
APPROVED BY THE FORMULATING COMMITTEE. IT IS BEING PREPARED FOR
FINAL REVIEW WHICH SHOULD OCCUR IN 1ST. QUARTER FY 71. KNOWLEDGE OF
THE METEOROID AND ASTEROID POPULATIONS AS WELL AS THE SOLAR, COSMIC
AND GEOMAGNETICALLY TRAPPED RADIATIONS WILL BE ASSESSED AND
RECOMMENDED VALUES GIVEN FOR ENGINEERING APPLICATION AND MISSION
STUDIES. THESE MONOGRAPHS WILL BE REVIEWED BY NASA AND NON-NASA
SCIENTISTS AND ENGINEERS TO INSURE THAT THE RESULTS ARE CONSISTENT
WITH THE STATE OF THE ART.

RTOP NO. 124-12-11 TITLE: SPACE VEHICLE DESIGN CRITERIA
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

THIS OVER GUIDELINES RTOP COVERS THE FOLLOWING OBJECTIVE EFFORT, ENVIRONMENTAL CRITERIA, MONOGRAPHS OF VARIOUS ENVIRONMENTS WILL BE PRODUCED, FOR SCIENTISTS, ENGINEERS, AND DESIGNERS, REFLECTING THE LATEST DATA AVAILABLE FOR EACH. THIS DATA PROVIDES THE ENVIRONMENTAL CRITERIA TO WHICH FUTURE VEHICLES MUST BE DESIGNED AND BUILT.

RTOP NO. 125-06-05 TITLE: AVIONICS MANAGEMENT SYSTEMS FOR PILOTING
STOL AIRCRAFT AND AIR TRAFFIC CONTROL

ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBINSON, R. G. TEL. 415-961-2286
TECHNICAL SUMMARY

FUTURE AIR TRAFFIC CONTROL SYSTEMS, WHICH CONSIST OF THE AIRCRAFT SYSTEM, THE INSTRUMENT LANDING SYSTEM, AND GROUND CONTROL AND DATA LINK, WILL BE AUTOMATED TO SOME DEGREE. EFFORTS ARE NEEDED TO INVESTIGATE SYSTEM CONCEPTS WHICH WOULD GUIDE FUTURE DESIGNERS OF THESE SYSTEMS IN DEFINING AN OPERATIONAL CONCEPT. RTCA SPECIAL COMMITTEE 117 IS PRESENTLY FORMULATING A CONCEPTUAL SYSTEM FOR A FUTURE INSTRUMENT LANDING SYSTEM. A STUDY AND REPORT BY THE DEPARTMENT OF TRANSPORTATION AIR TRAFFIC CONTROL ADVISORY COMMITTEE OUTLINES THE DIRECTION FOR FUTURE AIR TRAFFIC CONTROL SYSTEMS. IT IS POINTED OUT THAT FUTURE SYSTEMS WILL BE EMPHASIZING AUTOMATION BOTH ON THE GROUND AND IN THE AIR. AIRCRAFT COMPANIES AND AIRLINES HAVE BEEN EMPHASIZING THE NEED FOR USE OF AUTOMATION ON BOARD THE AIRCRAFT TO REDUCE PILOT WORK SO THAT THE PILOT CAN DEVOTE HIS TIME TO CRITICAL DECISION MAKING TASKS. THE AIRCRAFT COMPANIES HAVE BEEN RESPONDING TO THIS EMPHASIS BY CONDUCTING LIMITED FLIGHT INVESTIGATIONS OF AUTOMATIC AIRBORNE SYSTEMS. THE FLIGHT INVESTIGATIONS BY THE BOEING COMPANY ON THEIR 367-80 ARE TYPICAL OF THESE EFFORTS. TO DATE NO EFFORT HAS BEEN MADE TO BRING THE CONCEPTS OF THE RTCA SYSTEM, THE DEPARTMENT OF TRANSPORTATION AIR TRAFFIC CONTROL ADVISORY COMMITTEE CONCEPTS, AND THE CONCEPT OF AUTOMATIC CONTROL OF AIRCRAFT TOGETHER TO DEFINE A FUTURE AIR TRAFFIC CONTROL SYSTEM. SOME EFFORTS HAVE BEEN MADE TO INVESTIGATE THE MANNER IN WHICH AN INERTIAL SYSTEM ON BOARD AN AIRCRAFT COULD CONTRIBUTE TO AN AIR TRAFFIC CONTROL SYSTEM.

RTOP NO. 125-06-16 TITLE: AVIONIC SYSTEMS FOR TERMINAL AREA
NAVIGATION, SEQUENCING, AND FLOW
MANAGEMENT

ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-3285
TECHNICAL SUMMARY

THE LONG TERM OBJECTIVE IS THE DEVELOPMENT OF AVIONICS SYSTEMS

TECHNOLOGY TO PERMIT EFFECTIVE OPERATIONS IN THE AIR TRAFFIC ENVIRONMENT EXPECTED IN THE 1975-85 TIME PERIOD. EMPHASIS IS PLACED ON NAVIGATION, SEQUENCING, AND FLOW MANAGEMENT FROM THE ENROUTE PHASE THROUGHOUT THE TERMINAL AREA FOR CONVENTIONAL AND V/STOL AIRCRAFT. ALSO, ATTENTION WILL BE PLACED ON THE UNIQUE REQUIREMENTS OF V/STOL AIRCRAFT, SUCH AS PRECISION LOW-ALTITUDE NAVIGATION AND VTOL LANDING SYSTEMS. ADVANTAGE IS TAKEN OF THE INITIAL DIGITAL TECHNIQUES AND INERTIAL SYSTEMS WORK CONDUCTED AT ERC, RELATED PROGRAMS IN STOL DEVELOPMENT AT AMES, AND IMPROVEMENTS TO THE NATIONAL AIRSPACE SYSTEM PLANNED BY DOT. CONCURRENT AERONAUTICAL RESEARCH PROGRAMS AT LRC ON TERMINAL AREA OPERATING PRACTICES, HANDLING QUALITIES, AND STABILIZATION OF V/STOL AIRCRAFT ARE IMPORTANT CONSIDERATIONS. TERMINAL AREA TRAFFIC MODELING AND SIMULATION METHODS WILL BE DEVELOPED FOR APPLICATION IN EXAMINING SEQUENCING AND FLOW CONTROL FOR ALTERNATE MIXES OF AIRCRAFT. ADVANCED AUTOPILOT TECHNIQUES UTILIZING VARIOUS LEVELS OF ON-BOARD COMPUTING CAPABILITY WILL BE EXAMINED AND RELATED DIGITAL CONTROL COMPONENTS WILL BE DEVELOPED. PARTICULAR ATTENTION WILL BE PLACED ON ELECTRONICS RELIABILITY, SAFETY MONITORING, INSPECTION-TYPE ASSURANCE TESTING, DIAGNOSTICS, AND MULTI-MODE METHODS TO ELIMINATE THE EFFECTS OF FAILURES. ANALYSIS AND LABORATORY WORK, INCLUDING THE DESIGN AND EVALUATION OF DEVELOPMENTAL AVIONICS SYSTEM ELEMENTS USING COMPUTER SIMULATION OF VEHICLE CHARACTERISTICS, WILL BE FOLLOWED BY FLIGHT TESTS IN SELECTED RESEARCH AIRCRAFT. THIS EFFORT IS EXPECTED TO CONTRIBUTE TO THE DESIGN OF ADVANCED SYSTEMS WHICH MAY BE INTEGRATED INTO FUTURE "PROTOTYPE AIRCRAFT" PROGRAMS.

RTOP NO. 125-17-07 TITLE: EARTH-ORIENTED ATTITUDE REFERENCE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS WORK IS TO DEVELOP HORIZON SENSOR SYSTEMS AND TECHNOLOGY FOR SPACECRAFT, WITH SPECIAL EMPHASIS ON SPACE STATION/SPACE BASE. AN IR HORIZON SENSOR WILL BE DEVELOPED FOR THE POINTING ACCURACY RANGE OF 0.02 TO 0.05 DEGREES, AND THE ACCURACY POTENTIAL OF THE MICROWAVE AND ULTRAVIOLET SPECTRAL REGIONS FOR HORIZON SENSING WILL BE EXAMINED FROM BOTH INPUT PHENOMENA AND EQUIPMENT LIMITATIONS VIEWPOINTS. THE DEVELOPMENT OF COMPONENTS AND CALIBRATION TECHNIQUES REQUIRED TO EXPLOIT THE POTENTIAL OF HORIZON SENSOR SYSTEMS ARE ALSO OBJECTIVES OF THIS WORK. THIS RESEARCH WILL PROVIDE AN IMPROVED HORIZON SENSOR FOR SPACE STATION/SPACE BASE NAVIGATION AND GUIDANCE APPLICATIONS AND BASIC DESIGN AND EVALUATION CRITERIA FOR ADVANCED SENSORS IN OTHER NEAR EARTH SPACECRAFT.

RTOP NO. 125-17-11 TITLE: FLIGHT TEST AND OPERATIONS TECHNOLOGY
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: BURKE, M. E. TEL. 805-258-3311
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS EFFORT ARE TO EVALUATE AND ADVANCE FLIGHT TEST AND OPERATIONS TECHNOLOGY FOR SUPERSONIC AND HYPERSONIC AIRCRAFT

GUIDANCE, AND CONTROL. THE SPECIFIC EFFORTS UNDERWAY AT THE PRESENT TIME INCLUDE THE DEVELOPMENT OF A REAL TIME FLIGHT PATH OPTIMIZATION PROGRAM AND ATTENDANT AIRCRAFT SYSTEM AND THE DEVELOPMENT OF VISUAL SIMULATION CAPABILITIES. APPLICATIONS OF THE RESULTS OF THIS EFFORT MAY APPLY TO ADVANCED SUPERSONIC TRANSPORT AND/OR MANEUVERING MILITARY AIRCRAFT.

RTOP NO. 125-17-14 TITLE: NAVIGATION AND GUIDANCE ANALYSIS,
SYSTEMS, AND COMPONENTS FOR SPACE SYSTEMS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

NAVIGATION AND GUIDANCE TECHNIQUES RELATED TO OPTIMAL ORBITAL TRANSFER, AS WELL AS APPLICATION OF LSI MODULES AND OF RING LASER GYROS TO ADVANCED GUIDANCE AND NAVIGATION SYSTEMS, WILL BE INVESTIGATED AND DEVELOPED. THE SPECIFIC TASKS TO BE PURSUED IN FY-71 ARE: A. OPTIMAL GUIDANCE SYSTEM DEVELOPMENT FOR SPACECRAFT AND AEROSPACE VEHICLES. B. THREE-AXIS RING LASER GUIDANCE PLATFORM DEVELOPMENT. C. ANALOGUE CIRCUIT DIGITIZATION STUDY.

RTOP NO. 125-17-15 TITLE: GUIDANCE AND CONTROL FOR UNMANNED
PLANETARY VEHICLES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

THE GOAL OF THE GUIDANCE AND CONTROL WORK IN THIS PLAN IS TO DEVELOP THE ANALYTIC TOOLS AND BASIC TECHNOLOGY TO ACHIEVE THE REQUIRED IMPROVEMENTS IN SPACECRAFT DELIVERY ACCURACY AND ATTITUDE CONTROL CAPABILITY NECESSARY FOR THE MISSIONS TO THE OUTER PLANETS. NEW TECHNOLOGY APPROACHES MUST BE DEVELOPED OVER THOSE USED DURING THE PAST DECADE IN ORDER TO MEET THE MORE STRINGENT REQUIREMENTS OF A MISSION LIKE THE GRAND TOUR. INCREASES IN DELIVERY ACCURACY WILL RESULT FROM IMPROVEMENTS IN ESTIMATING THE SPACECRAFT TRAJECTORY (ORBIT DETERMINATION), IMPROVEMENTS IN THE STRATEGY FOR MULTIPLE MANEUVER MISSIONS AND IMPROVEMENTS IN THE EXECUTION OF MANEUVERS. THE DEVELOPMENT OF AN ON-BOARD OPTICAL APPROACH GUIDANCE, TO AUGMENT THE GROUND-BASED DATA, COUPLED WITH ADVANCES IN SENSOR TECHNOLOGY SHOWS PARTICULAR PROMISE TO THE REALIZATION OF THESE ACCURACIES. BECAUSE THESE MISSIONS REQUIRE LIFETIMES OF FROM 10 TO 12 YEARS, A SIGNIFICANT ADVANCES ARE ALSO REQUIRED IN THE RELIABILITY OF THE GUIDANCE AND CONTROL SUBSYSTEMS THROUGH ADVANCEMENTS IN COMPONENT TECHNOLOGY. THE BASIC ELEMENTS OF THE FY'71 TECHNICAL PLANS ARE THESE: 1) A TWO PART PROGRAM FOR THE DEVELOPMENT OF OPTICAL APPROACH GUIDANCE. THE FIRST PART WILL BE DIRECTED AT EXTENDING THE APPROACH GUIDANCE TECHNOLOGY DEMONSTRATED ON MM'69 THROUGH A FLIGHT DEMONSTRATION USING THE SATELLITE AND STAR DATA TYPES, AVAILABLE FROM MM'71 WHICH OFFERS THE GREATEST POTENTIAL FOR FUTURE MISSIONS. THE SECOND IS A DESIGN AND DEVELOPMENT EFFORT DIRECTED AT THE SPECIAL PROBLEMS OF THE OUTER PLANET MISSIONS. 2) THE DEVELOPMENT OF MANEUVER STRATEGIES AND IMPROVED GUIDANCE SIMULATION PROGRAMS FOR THE

OUTER PLANET MISSION. 3) THE CONTINUED DEVELOPMENT AND APPLICATION OF FLEXIBLE BODY ANALYSES FOR APPLICATION IN THE ATTITUDE CONTROL SYSTEM DESIGN. 4) AN EFFORT TO REALIZE THE NECESSARY IMPROVEMENTS IN SENSOR ACCURACY, RELIABILITY, AND LIFETIME THROUGH THE DEVELOPMENT OF IMPROVED OPTICAL SENSORS.

RTOP NO. 125-17-18 TITLE: ALL-WEATHER INDEPENDENT LANDING MONITOR
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

A DISPLAY SYSTEM WILL BE DEVELOPED WHICH CAN BE PLACED IN THE COCKPIT OF AN AIRPLANE AND WILL PRESENT A VISUAL PICTURE OF THE RUNWAY AND ADJACENT TERRAIN THROUGH MICROWAVE SENSING DURING A LANDING APPROACH WHEN NORMAL VISIBILITY IS IMPAIRED. A STUDY WILL BE MADE TO DETERMINE WHETHER SUCH A SYSTEM COULD BE MADE TO WORK WITHOUT RELIANCE ON ACTIVE GROUND LANDING AIDS, BUT ONLY ON DIFFERENCES IN APPARENT TEMPERATURE OF TERRAIN AT MICROWAVE FREQUENCIES. CONSIDERATION WILL ALSO BE GIVEN TO THE DESIRABILITY OF AUGMENTING PERFORMANCE BY ACTIVE POINT SOURCES ALONG THE RUNWAY SUCH AS LOW COST MICROWAVE EMITTERS AND BY HIGH INTENSITY MU-WAVE FLOOD LIGHTS ILLUMINATING THE AIRPORT SCENE. RESEARCH WILL INCLUDE STUDIES OF HUMAN FACTORS SUCH AS THE SIZE OF THE VISUAL DISPLAY, THE FIELD OF VIEW OF THE MICROWAVE SYSTEM, IMAGE RESOLUTION AND UPDATE RATE, REQUIREMENT FOR COLLIMATION, HEAD-UP OR HEAD-DOWN DISPLAY, AND BEAM-SPLITTER VERSUS PANEL DISPLAY. FURTHER OBJECTIVES OF THIS RESEARCH WOULD BE TO CONSIDER SIMILAR SYSTEMS FOR COLLISION AVOIDANCE BY DETECTING THE APPROACH OF OTHER AIRPLANES WITH THE SAME ANTENNA SYSTEM AND VISUAL DISPLAY. SINCE THE SPACE SHUTTLE VEHICLE WILL REQUIRE INSTRUMENTATION TO PERMIT LANDING IN ADVERSE WEATHER CONDITIONS, ANOTHER OBJECTIVE OF THIS SYSTEM DEVELOPMENT WOULD BE THE APPLICATION OF THE SSV.

RTOP NO. 125-17-19 TITLE: TERMINAL AREA GUIDANCE AND CONTROL
SYSTEMS FOR STOL AIRCRAFT

ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBINSON, R. G. TEL. 415-961-1111
TECHNICAL SUMMARY

RESEARCH STUDIES AT AMES RESEARCH CENTER HAVE BEEN DIRECTED TO EXAMINE CONCEPTS FOR MORE PRECISE NAVIGATION OF STOL AIRCRAFT IN THE TERMINAL AREA AND TO STUDY METHODS OF PRESENTING THIS INFORMATION TO THE PILOT. PROBLEMS ASSOCIATED WITH FLIGHT DIRECTORS FOR STOL AIRCRAFT HAVE BEEN ASSESSED IN A PRELIMINARY WAY. SOME FLIGHTS HAVE BEEN MADE WITH A VISUAL FLIGHT PATH INDICATOR TO ASSIST THE STOL AIRCRAFT PILOT TO SET UP SATISFACTORY APPROACH PATHS IN REGIMES WHERE INSTRUMENT LANDING AIDS ARE NOT AVAILABLE. SIMULATOR STUDIES HAVE DERIVED DISPLAY CONCEPTS WHICH APPEAR PROMISING FOR LOW-VISIBILITY LANDINGS FOR STOL AIRCRAFT. THESE DISPLAY CONCEPTS UTILIZE A HEAD-UP DISPLAY TECHNIQUE TO KEEP THE PILOT IN THE CONTROL LOOP. THE CONVAIR 340 AIRCRAFT IS CURRENTLY INVOLVED IN IN-FLIGHT INVESTIGATIONS OF SOME OF THESE CONCEPTS. SOME PRELIMINARY INVESTIGATIONS HAVE BEEN

MADE OF DIGITAL FLIGHT CONTROL SYSTEMS FOR AUTOMATIC LANDING. A TURBULENCE MODEL HAS BEEN DEVELOPED FOR USE IN SIMULATION STUDIES OF THESE CONCEPTS.

RTOP NO. 125-17-20 TITLE: CELESTIAL ATTITUDE REFERENCE SYSTEMS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS WORK IS TO DEVELOP SENSOR TECHNOLOGY, DATA PROCESSING AND REDUCTION TECHNIQUES, AND CANDIDATE SENSOR DESIGNS FOR OBTAINING CONTINUOUS ATTITUDE TIME HISTORY FROM STAR SIGHTINGS FOR SPACE STATION APPLICATIONS. THE ATTITUDE DETERMINATION NEEDS OF THE SPACE STATION/SPACE BASE WILL BE INVESTIGATED BASED ON CURRENT DESIGN STUDIES. CELESTIAL ATTITUDE DETERMINATION OF SPINNING SPACECRAFT USING PASSIVELY SCANNED STAR TRANSIT SENSORS WILL BE STUDIED. THE USE OF BODY MOUNTED ELECTRONICALLY-SCANNED, WIDE-FIELD SENSORS FOR ATTITUDE DETERMINATION OF THREE-AXIS STABILIZED SPACECRAFT WILL BE INVESTIGATED. SENSOR TECHNOLOGY WILL BE DEVELOPED FOR BOTH APPLICATIONS, WITH SPECIAL EMPHASIS ON STRAY LIGHT SHIELDING. THE DEVELOPMENT OF SENSOR TECHNOLOGY AND DATA HANDLING TECHNIQUES FOR BOTH SPINNING AND NONSPINNING SPACECRAFT WILL PERMIT THE USE OF BODY-MOUNTED STAR SENSORS ON THE SPACE STATION/SPACE BASE, THUS IMPROVING SYSTEM ELECTRO-MECHANICAL RELIABILITY AND LIFETIME.

RTOP NO. 125-17-21 TITLE: OPTICAL RENDEZVOUS AND DOCKING SENSORS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

A COMPLETELY AUTOMATIC RENDEZVOUS AND DOCKING SYSTEM WILL BE DEVELOPED TO MEET THE SPACE SHUTTLE REQUIREMENTS. THIS RESEARCH PROGRAM WILL DEVELOP THE SYSTEM TO BE COMPATIBLE WITH THE SHUTTLE GUIDANCE AND CONTROL AND VEHICLE INTERFACES. THE SPACE SHUTTLE WILL REQUIRE A SYSTEM THAT PERMITS AUTOMATIC RENDEZVOUS AND DOCKING WITH BOTH COOPERATIVE AND UNCOOPERATIVE SATELLITES AND TARGETS. THE GOAL OF THIS PROGRAM IS TO REDESIGN THE EXISTING ADVANCED OPTICAL RENDEZVOUS AND DOCKING SYSTEM AND DEVELOP A FLIGHT QUALIFIED SYSTEM THAT WILL PERMIT THE SPACE SHUTTLE TO MEET THESE REQUIREMENTS. THE SHUTTLE RENDEZVOUS AND DOCKING SYSTEM WILL BE EXTENSIVELY OPERATIONALLY AND ENVIRONMENTALLY TESTED TO PROVE THE INTEGRITY OF THE SYSTEM. INFORMATION WILL BE FURNISHED TO SUPPORT THE SHUTTLE PHASE B AND C STUDIES. THE RENDEZVOUS AND DOCKING SYSTEM WILL BE CONTINUALLY UPGRADED, BASED UPON PHASE B STUDIES, WITH IMPROVED OPTICAL AND RELATED DEVICES AS THEY BECOME AVAILABLE THAT WILL PROVIDE PERFORMANCE AND EFFICIENCY ENHANCEMENT. SYSTEM SPECIFICATIONS WILL BE DEVELOPED FOR PROCUREMENT OF FLIGHT QUALIFIED SYSTEMS HARDWARE.

RTOP NO. 125-17-22 TITLE: INVESTIGATION OF TERMINAL AREA
NAVIGATION, GUIDANCE, AND DISPLAY CONCEPTS
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: GEE, S. W. TEL. 805-258-3311
TECHNICAL SUMMARY

AN ANALYTICAL STUDY WILL BE CONDUCTED TO INVESTIGATE THE TERMINAL AREA GUIDANCE AND CONTROL LAWS TO PROVIDE AN IFR CIRCLING APPROACH CAPABILITY FOR A CANDIDATE CONFIGURATION OF A SPACE SHUTTLE VEHICLE. A COMPUTER SIMULATION USING THE VEHICLE EQUATIONS OF MOTION AND A COCKPIT WITH CHANGEABLE DISPLAYS WILL BE USED TO EVALUATE A GUIDANCE SCHEME AND PILOT WORKLOAD. THE SIMULATION RESULTS WILL BE VALIDATED BY FLIGHT TESTS OF THE GUIDANCE AND DISPLAY SYSTEMS IN AN F-104 IN LOW L/D CONFIGURATION. ADDITIONALLY, THE AVAILABLE INFORMATION ON ENERGY MANAGEMENT AND PREDICTIVE GUIDANCE TECHNIQUES WILL BE COMPILED INTO A SINGLE DOCUMENT.

RTOP NO. 125-17-33 TITLE: MANNED SPACE SHUTTLE: INVESTIGATION OF
SYSTEMS FOR NAVIGATION, GUIDANCE AND
CONTROL DURING APPROACH AND LANDING
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBINSON, R. G. TEL. 415-961-2280
TECHNICAL SUMMARY

FOLLOWING REENTRY FROM ORBIT, THE SPACE SHUTTLE VEHICLE (SSV) MUST HAVE THE CAPABILITY TO PERFORM CATEGORY II LANDINGS AS SPECIFIED BY THE FAA AND MUST BE ABLE TO LAND AUTOMATICALLY. THIS MUST BE ACCOMPLISHED WITH A VEHICLE WHICH MAY BE, IN MANY WAYS, DIFFERENT FROM A CURRENT JET TRANSPORT (E.G., UNPOWERED, LOW L/D, ETC.). SUPPORTING RESEARCH IS NEEDED TO DETERMINE AUTOMATIC AND MANUAL CONTROL, GUIDANCE, AND NAVIGATION SYSTEM CONCEPTS FOR THE SSV IN THE TERMINAL AREA AND LANDING FLIGHT PHASES. THE OBJECTIVE OF THIS RESEARCH PROGRAM IS TO PROVIDE TECHNOLOGY FOR THE DESIGN OF THE SSV TERMINAL AREA NAVIGATION, GUIDANCE, AND CONTROL SYSTEM. A PILOTED FLIGHT SIMULATION OF THE APPROACH AND LANDING PHASES OF FLIGHT WILL BE CONDUCTED IN-HOUSE TO ACCOMPLISH THIS OBJECTIVE. THE FOLLOWING TASKS ARE PLANNED FOR THIS SIMULATION: A. EXAMINATION OF THE PERFORMANCE OF GUIDANCE AND CONTROL CONCEPTS WHICH HAVE BEEN ESTABLISHED AS CANDIDATES TO SATISFY THE REQUIREMENTS OF THE SHUTTLE VEHICLE IN THE TERMINAL AREA. B. EXAMINATION OF RECOMMENDED HANDLING QUALITIES CRITERIA FOR THE SHUTTLE VEHICLE. C. EXAMINATION OF THE RECOMMENDED FLARE AND DECRAB PROCEDURES FOR THE SHUTTLE VEHICLE.

RTOP NO. 125-19-08 TITLE: AIRCRAFT FLIGHT CONTROL SYSTEMS AND
COMPONENTS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP PRACTICAL DESIGN TECHNIQUES AND CONTROL COMPONENTS FOR APPLICATION TO THE PROBLEM OF OBTAINING FLIGHT CONTROL SYSTEMS FOR AIRCRAFT RANGING IN COMPLEXITY

FROM GENERAL AVIATION AIRCRAFT TO LARGE, HIGH SPEED, FLEXIBLE AIRCRAFT. NONLINEAR PROGRAMING AND VARIATIONAL TECHNIQUES WILL BE UTILIZED TO ESTABLISH DESIGN PROCEDURES. METHODS OF EXTRACTING PARAMETERS FROM FLIGHT DATA WILL BE INVESTIGATED AS A MEANS OF PROVIDING THE AERODYNAMIC INFORMATION REQUIRED FOR DESIGN. THE DEVELOPMENT OF RELIABLE, LOW COST FLIGHT CONTROL SYSTEMS FOR GENERAL AVIATION AIRCRAFT WILL BE SOUGHT THROUGH EXPERIMENTATION WITH AND ANALYSES OF FLUIDIC COMPONENTS. DIGITAL CONTROL TECHNIQUES WILL BE DEVELOPED FOR APPLICATION TO THE MORE COMPLEX FLIGHT CONTROL SYSTEMS REQUIRED BY HIGH PERFORMANCE AIRCRAFT.

RTOP NO. 125-19-09 TITLE: AVIONIC SUBSYSTEM TECHNOLOGY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-3285
TECHNICAL SUMMARY

GENERAL AVIATION COCKPIT ELECTRONIC AIDS WHICH CONTRIBUTE TO FLIGHT SAFETY AND HAVE A POTENTIAL FOR LOW-COST WILL BE INVESTIGATED, DEVELOPED, AND FLIGHT TESTED. ALSO, A POSITION DETERMINATION SYSTEM USING LOW-FREQUENCY NAVIGATION TECHNIQUES WILL BE DEVELOPED TO PROVIDE AN IMPROVED NAVIGATION CAPABILITY FOR GENERAL AVIATION. AN AIRCRAFT DATA LINK CAPABLE OF PROVIDING THE ATC SYSTEM WITH THE DATA NECESSARY FOR AN ACCURATE ACCOUNT OF THE AIR TRAFFIC SITUATION WILL BE DEVELOPED. STUDIES WILL BE MADE TO DEFINE THE DATA TRANSFER REQUIREMENTS AND SYSTEM LOADING. A MORE EFFICIENT USE OF THE PRESENT AIR-TO-GROUND-TO-AIR COMMUNICATIONS LINK IN THE ATC SYSTEM WILL BE MADE IN THE EFFORT TO PROVIDE A RELATIVELY LOW-COST SYSTEM FOR GENERAL AVIATION USE.

RTOP NO. 125-19-12 TITLE: SPACECRAFT LOGIC AND ATTITUDE CONTROL SYSTEMS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

ACTIVE STABILIZATION AND CONTROL OF UNMANNED SATELLITES HAS BEEN DEMONSTRATED FOR SMALL OR LARGE SLOWLY PROGRAMMED MOTIONS. A THEORY HAS BEEN DERIVED AT AMES TO ANALYZE THE PERFORMANCE OF ACTIVELY STABILIZED SPACECRAFT OVER ALL REGIONS OF OPERATION BY COMPARISON TO STABILITY OF KNOWN RESPONSE FUNCTIONS. THIS RESPONSE FUNCTION CONCEPT HAS EVOLVED FROM A THEORY OF STABILITY ANALYSES BASED ON EULER'S THEOREM ON ROTATION. CURRENT FAILURES IN CONTROL AND STABILIZATION OF PASSIVELY STABILIZED SPACECRAFT ILLUSTRATE THE FACTORS AFFECTING THE STABILIZATION OF THESE VEHICLES ARE NOT COMPLETELY UNDERSTOOD. A SERIES OF GRAVITY GRADIENT STABILIZED SATELLITES WILL BE LAUNCHED BY THE NAVAL RESEARCH LABORATORIES. DATA FROM THESE SATELLITES WILL BE AVAILABLE TO ASSIST IN DEFINING UNKNOWN DISTURBANCES OF EXISTING STABILIZATION CONCEPTS. SEVERAL ADVANCED SENSOR AND SYSTEM DEVELOPMENTS ARE UNDERWAY. THESE CONSIST OF (1) A SOLAR ASPECT SENSOR FOR EXPERIMENT ALIGNMENT, (2) A HYDRAZINE REACTION JET THRUSTER SYSTEM, AND (3) AN ADAPTIVE PNEUMATIC ATTITUDE CONTROL SYSTEM. OTHER DEVELOPMENTS BEING STUDIED INCLUDE (1) A

FLUIDIC ANGULAR RATE SENSOR WITH AN ELECTRICAL OUTPUT, (2) A FLUIDIC ASTRONAUT MANUEVERING CONTROL, AND (3) ATTITUDE CONTROL SYSTEMS FOR PRECISE POINTING OF REUSEABLE SUBSATELLITES.

RTOP NO. 125-19-13 TITLE: MANNED FLIGHT CONTROL SYSTEMS THEORY AND TECHNOLOGY

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: KLEIN, H. P. TEL. 415-961-2735

TECHNICAL SUMMARY

RESEARCH IS BEING CONDUCTED TO DESCRIBE AND PREDICT HUMAN CAPABILITIES IN OPERATING MANNED CONTROL SYSTEMS. THE ANALYTIC TECHNIQUES OF SERVO-SYSTEMS ANALYSIS AND INFORMATION THEORY, INTERACTIVE WITH THE RESULTS OF EXPERIMENTS CONDUCTED WITH HUMAN SUBJECTS, ARE BEING UTILIZED TO MODEL HUMAN BEHAVIOR AND TO DETERMINE LIMITATIONS IN HUMAN CAPACITY FOR PERFORMANCE. THE RESULTS OF THESE EFFORTS HAVE BEEN THE PRODUCTION OF TECHNIQUES AND A BODY OF KNOWLEDGE USEFUL IN DETERMINING OPTIMAL INFORMATION DISPLAY-PILOT-VEHICLE-CONTROL INTERFACING, AS WELL AS MAKING ANALYTICAL AIRCRAFT HANDLING QUALITY EVALUATIONS FEASIBLE. THE RESULTS OF CURRENT EFFORTS WILL EXTEND THESE TECHNIQUES AND KNOWLEDGE TO INCLUDE THE PREDICTION OF WORKLOAD AND THE OPTIMIZATION OF HUMAN PERFORMANCE IN MULTI-DIMENSIONED TASKS SUCH AS AN AIRCRAFT APPROACH AND LANDING TASK.

RTOP NO. 125-19-14 TITLE: ADVANCED FLIGHT CONTROL SYSTEMS AND DISPLAYS

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: BURKE, M. E. TEL. 805-258-3311

TECHNICAL SUMMARY

THE TOTAL PROGRAM IS A COORDINATED EFFORT TO PROVIDE AVIONIC SYSTEM TECHNOLOGY, DEVELOPMENT AND CRITERIA THAT WILL CONTINUE THE IMPROVEMENTS IN SAFETY AND UTILITY OF ALL AIRCRAFT, PARTICULARLY GENERAL AVIATION TYPE AIRCRAFT. VARIOUS NEW CONCEPTS IN FLIGHT CONTROL, NAVIGATION, AND DISPLAY SYSTEMS ARE BEING INVESTIGATED THROUGH THE USE OF SIMULATORS AND FLIGHT VEHICLES THAT WILL EVENTUALLY PERMIT COMPLETELY AUTOMATIC FLIGHT THROUGH AIRBORNE AND GROUND CONTROL COMPUTER PROGRAMMING.

RTOP NO. 125-19-20 TITLE: APPLICATION OF CONTROL AND GUIDANCE THEORY AND MATHEMATICAL MODELING TECHNIQUES TO AIRCRAFT SYSTEMS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, L. TEL. 415-961-2280

TECHNICAL SUMMARY

DUE TO EFFORTS AT AMES RESEARCH CENTER AND ELSEWHERE THERE EXIST METHODS TO EXPAND APPLICATION OF LINEAR THEORETICAL ANALYSES TO ACTUAL SYSTEMS WHICH ARE NONLINEAR. ONE SPECIFIC CONCEPT WHICH HAS BEEN DERIVED AT AMES IS A REITERATIVE DIGITAL COMPUTATIONAL CONCEPT

FOR DERIVING INITIAL CONDITIONS FOR THE SOLUTION OF PONTRYAGIN'S MAXIMUM PRINCIPLE APPLIED TO HIGH ORDER NONLINEAR SYSTEMS. PROGRAMS HAVE BEEN DEVELOPED TO APPLY THE METHODS OF STEEPEST DESCENT DYNAMIC PROGRAMMING AND KALMAN STATISTICAL FILTERING TO ENGINEERING PROBLEMS.

IN-HOUSE AND CONTRACT STUDIES HAVE STUDIED OBSERVABILITY AND CONTROLLABILITY. MATHEMATICAL MODELING OF HUMAN RESPONSE CHARACTERISTICS HAS BEEN SUCCESSFUL IN DERIVING TRANSFER FUNCTIONS OR PILOT-DESCRIBING FUNCTIONS FOR SIMPLE SINGLE-AXIS TRACKING TASKS FOR PRESCRIBED INPUTS. THIS WORK HAS BEEN EXTENDED TO THE DETERMINATION OF PILOT-DESCRIBING FUNCTIONS FOR SIMPLE TASKS FROM ACTUAL FLIGHT RECORDS. THIS EXTENSION INCLUDES A METHOD OF DERIVING A MODEL OF THE SYSTEM BEING OPERATED BY THE PILOT. IN ADDITION, THE KALMAN STATISTICAL APPROACH AND COMPUTATIONAL TECHNIQUES, SUCH AS THE NEWTON RAPHSON METHOD, HAVE BEEN USED WITH SOME SUCCESS IN THE IDENTIFICATION OF SYSTEM TRANSFER FUNCTIONS AND PARAMETERS. THEORETICAL STUDIES TO EXPAND EXISTING THEORIES HAVE BEEN SUPPORTED UNDER CONTRACT AND GRANTS TO UNIVERSITIES.

RTOP NO. 125-19-21 TITLE: ADVANCED RESEARCH ON MANUAL & AUTOMATIC GUIDANCE & CONTROL SYSTEMS, COMPONENTS & TECHNIQUES

ORGANIZATION: NASA HEADQUARTERS

MONITOR: JANOW, C.

TEL. 202-962-7294

TECHNICAL SUMMARY

RESEARCH IN THIS AREA IS DIRECTED TOWARDS OPTIMIZING AEROSPACE CONTROL SYSTEMS AND MAN'S ROLE IN OPERATING AND CONTROLLING AIRCRAFT; DEVELOPING ANALYTICAL TOOLS, TECHNIQUES AND COMPONENTS AND EVALUATING ADVANCED CONCEPTS APPLICABLE TO FUTURE NASA MISSIONS. THE PROGRAM COVERS RESEARCH IN AND APPLICATION OF AUTOMATIC AND MANUAL CONTROL THEORY, MODELING TECHNIQUES, DIGITAL CONTROL TECHNIQUES AND FILTER THEORY, COMPUTER ORGANIZATION AND CONTROL ALGORITHMS. DESIGN ANALYSIS TO BE PURSUED WILL LEAD TO THE DEFINITION AND DEVELOPMENT OF CONTROL SYSTEMS. ADVANCED COMPONENTS UTILIZING FLUIDIC PHENOMENA AND ELECTROMECHANICAL ARRANGEMENTS WILL BE INVESTIGATED AND ADVANCED FOR USAGE IN CONTROL SYSTEM FUNCTIONS. EMPHASIS IS PLACED ALSO ON MODELING THE DECISIONS WHICH HUMAN CONTROLLERS FACE IN EXTREME AND NORMAL SITUATIONS AND AN EXAMINATION OF THE DYNAMIC PROCESSES OCCURRING WITHIN THE VISUAL, VESTIBULAR AND NEUROMUSCULAR SYSTEMS OF THE HUMAN. THE RESEARCH COVERED BY THIS RTOP WILL BE CONDUCTED AT UNIVERSITIES OR NON-PROFIT RESEARCH CENTERS WITH NASA CENTERS PROVIDING TECHNICAL MONITORING ASSISTANCE.

RTOP NO. 125-19-23 TITLE: LOAD RELIEF AND GUST ALLEVIATION CONTROL SYSTEM TECHNOLOGY FOR ILRV SPACE VEHICLES

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G.

TEL. 205-453-1120

TECHNICAL SUMMARY

THE REQUIREMENT FOR THE DELIVERY OF A LARGE PAYLOAD INTO ORBIT BY A LOW-COST REUSEABLE SPACE VEHICLE, AT ANY TIME (HIGHWINDS, BAD WEATHER CONDITIONS), AND FOR RETURN BOTH BOOSTER AND ORBITER IN O/O

LANDING CONDITIONS DICTATES THAT STRUCTURAL LOADING AND CYCLIC LOADING (FATIGUE) BE KEPT TO A MINIMUM. THE DESIGN OF THIS LOAD ALLEVIATION CONTROL SYSTEM IS COMPLICATED BY VARIOUS MISSION REQUIREMENTS, PIGGY-BACK STRUCTURES, UNSYMMETRICAL DYNAMICS AND STRUCTURAL COUPLING AND LARGE AERODYNAMIC SURFACES. STRONG COUPLING BETWEEN GUIDANCE AND CONTROL DURING THE LANDING PHASE ADDS ADDITIONAL COMPLEXITY. TWO BASIC TECHNICAL AREAS TO BE STUDIED IN THE CONTROL SYSTEM ARE: (1) REDUCTION OF MEAN WIND SPEED STRUCTURAL LOADS (LOAD REDUCTION) (2) GUST ALLEVIATION (BENDING MODE SUPPRESSION). THE STUDY WILL DEVELOP THE CONTROL LOGIC TO MEET THE LOAD REDUCTION AND GUST ALLEVIATION REQUIREMENTS OF TYPICAL ILRV SPACE VEHICLE AND INTEGRATE IT INTO A TYPICAL SYSTEM.

RTOP NO. 125-19-25 TITLE: CONTROL COMPONENTS AND SUBSYSTEM RESEARCH
AND TECHNOLOGY FOR SPACE STATION/BASE

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THIS WORK WILL GENERATE AND DEVELOP THE ADVANCED COMPONENT AND SUBSYSTEM TECHNOLOGY REQUIRED FOR LARGE MANNED SPACECRAFT CONTROL AND STABILIZATION SYSTEMS. BOTH SPACECRAFT CONTROL AND EXPERIMENT PACKAGE ISOLATION AND CONTROL WILL BE INVESTIGATED. SPECIFIC AREAS OF TECHNOLOGY TO BE INCLUDED ARE EXPERIMENT MODULE ISOLATION AND POINTING, CONTROL SYSTEM COMPONENT OPTIMIZATION (E.G. CONTROL MOMENT GYRO TORQUERS), AND COMPUTER/HARDWARE SUBSYSTEMS. OBJECTIVES ARE TO GENERATE AND ANALYZE ADVANCED CONTROL CONCEPTS WHICH CAN BE APPLIED TO FUTURE MANNED SPACE MISSIONS (SUCH AS THE SPACE STATION/BASE FOR INTERPLANETARY FLIGHTS), AND TO DEVELOP AND EVALUATE ADVANCED PROTOTYPE CONTROL SYSTEM COMPONENTS HAVING HIGH RESPONSE, HIGH RELIABILITY, AND LONG LIFE. COMPUTER SIMULATION TECHNIQUES WILL BE USED TO ESTABLISH STABILIZATION SUBSYSTEM AND COMPONENT REQUIREMENTS FOR TYPICAL DISTURBANCE AND MISSION PROFILES. ADVANCED HARDWARE CONCEPTS WILL BE INITIALLY SIMULATED AND SUBSEQUENT PROTOTYPES BUILT AND EVALUATED USING EXISTING REAL-TIME HYBRID COMPUTATION AND HARDWARE TEST FACILITIES. PRIMARY PROBLEMS REQUIRING SOLUTIONS INCLUDE EXTENSION OF CONTROL ACTUATOR AND SYSTEM BANDWIDTH AND LIFE TIME, AND THE ACCURATE POINTING AND TRACKING WITH ADVANCED EXPERIMENT MODULES. LARC WORK IN DEFINING AND EVALUATING APOLLO TELESCOPE MOUNT (ATM) CONTROL SYSTEMS CONCEPTS AND HARDWARE WILL BE USED AS A BASE FOR EXTENSION TO MISSIONS REQUIRING ADVANCED CONTROL CONCEPTS AND SYSTEM COMPONENTS. LOW-COST, MULTIPURPOSE EXPERIMENT PLATFORMS WILL BE DEFINED AND ANALYTICALLY MODELED TO IDENTIFY COMPONENT DESIGN REQUIREMENTS. RESULTS OF THIS WORK WILL BE APPLICABLE TO THE MANNED SPACE STATION/BASE, TO INTERPLANETARY MISSIONS, TO ASTRONOMY AND EARTH RESOURCES EXPERIMENTS, AND TO LARGE DEFRACTION-LIMITED, ORBITAL TELESCOPES.

RTOP NO. 125-19-26 TITLE: CONTROL AND STABILIZATION SYSTEM RESEARCH
AND TECHNOLOGY FOR SPACE STATION/BASE

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THIS WORK WILL GENERATE THE CONTROL AND STABILIZATION SYSTEM TECHNOLOGY FOR THE MANNED SPACE STATION/BASE. COMPUTER SIMULATIONS OF THE SPACE STATION AND SPACE BASE WILL BE USED TO DEVELOP INTEGRATED CONTROL AND STABILIZATION SYSTEM CONCEPTS FOR ANTICIPATED DISTURBANCE AND MISSION PROFILES. PROTOTYPE LABORATORY SPACECRAFT CONTROL SYSTEM HARDWARE WILL BE INCORPORATED IN REAL-TIME DIGITAL COMPUTER-HARDWARE SIMULATIONS OF ACQUISITION, FINE-POINTING, DOCKING, AND MANEUVER TASKS FOR ZERO AND ARTIFICIAL GRAVITY OPERATIONAL MODES.

STABILIZATION AND CONTROL OF SPACE STATION/BASE ARTIFICIAL AND ZERO-GRAVITY CONFIGURATIONS WILL THEN BE EVALUATED THROUGH GROUND AND FLIGHT TESTS. SPACE BASE WOBBLE-DAMPING AND MASS BALANCING TECHNIQUES WILL BE VERIFIED THROUGH DIGITAL COMPUTER AND SCALED MODEL SIMULATIONS. RESULTS OF THIS WORK WILL BE DIRECTLY APPLICABLE TO THE NASA MANNED SPACE STATION AND SPACE BASE CONTROL AND STABILIZATION SYSTEM DEVELOPMENT. LANGLEY EXPERIENCE IN DEFINING AND EVALUATING THE ATM CLUSTER CONTROL SYSTEM HAS SHOWN THAT CURRENT SPACECRAFT STABILIZATION AND CONTROL SYSTEM TECHNOLOGY IS INADEQUATE FOR THE HIGH ACCURACY, LONG-TERM SPACE STATION/BASE MISSION. THE COMPUTER-HARDWARE SIMULATION EFFORTS (SUPPORTED BY SCALE MODEL AND POSSIBLE FLIGHT TESTS) ARE NEEDED TO DEVELOP THE NECESSARY CONTROL AND STABILIZATION SYSTEM CAPABILITY.

RTOP NO. 125-19-27 TITLE: CONTROL COMPONENTS AND SYSTEMS FOR SPACE
STATION/SPACE BASE

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: EVANS, H. E. TEL. 301-982-5194

TECHNICAL SUMMARY

THIS TASK COVERS RESEARCH, DESIGN AND EVALUATION OF ADVANCED CONTROL AND STABILIZATION COMPONENTS AND RELATED CONTROL CIRCUITRY FOR MANNED SPACECRAFT WITH LONG-DURATION MISSIONS. COMPONENTS AND CONTROL SYSTEMS FOR BOTH SPACECRAFT AND ON-BOARD EXPERIMENT PLATFORM CONTROL SYSTEMS ARE INCLUDED. FOR HIGH POINTING ACCURACY SYSTEMS, PROTOTYPE COMPONENTS AND CONTROL SYSTEMS WILL BE DEVELOPED TO EXTEND BANDWIDTH AND ELIMINATE HARDWARE LIMIT CYCLING BY USING UNIQUE DESIGNS THAT MINIMIZE PERTURBATING FORCES DUE TO FRICTION AND WEAR. THE ULTIMATE OBJECT OF THIS WORK IS SYSTEM CONTROL POINTING ACCURACY OF 0.01 SECOND OF ARC AND AN OPERATING LIFE OF TEN YEARS. COMPONENT TECHNOLOGY ADVANCEMENTS INCLUDE THE TECHNICAL BREAK-THROUGH IN THE AREA OF ELECTRONIC COMMUTATION. THIS MOTOR CONCEPT IS INTEGRATED INTO CONTROL ACTUATOR DESIGNS SUCH AS PRIME MOVERS FOR THE CONTROL MOMENT GYRO GIMBALS, SPIN MOTOR, SPACECRAFT EXPERIMENT PLATFORMS AND OTHER SIMILAR APPLICATIONS REQUIRING RELIABLE AND HIGH PRECISE PERFORMANCE. SPEED AND POSITION CONTROL SYSTEMS COMPATIBLE WITH THIS NEW CONCEPT FORM PART OF THIS WORK. ADVANCED MOTOR DESIGNS UTILIZING ROTOR SUSPENSION TECHNIQUES TO ELIMINATE OR MINIMIZE WEAR-OUT PRONE PARTS SUCH AS BEARINGS ARE ALSO INCLUDED. FLIGHT TESTING, WHERE APPROPRIATE FOR CORRELATION OF GROUND TEST DATA, WILL BE CONDUCTED.

RESULTS FROM THIS WORK ARE DIRECTLY APPLICABLE TO THE MANNED SPACE STATION/SPACE BASE AND TO ASTRONOMY AND EARTH RESEARCH EXPERIMENTS.

RTOP NO. 125-19-28 TITLE: LOAD RELIEF AND GUST ALLEVIATION CONTROL
SYSTEM RESEARCH AND TECHNOLOGY - SPACE
STATION/BASE LAUNCH VEHICLE

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

THE REQUIREMENT FOR THE DELIVERY OF A VARIETY OF PAYLOADS INTO ORBIT FOR A WIDE RANGE OF LAUNCH WINDOWS DICTATES A CONTROL SYSTEM WHICH WILL EFFECTIVELY PROVIDE LOAD RELIEF AND STRUCTURAL MODAL SUPPRESSION OF THE SPACE STATION/BASE LAUNCH VEHICLE AND PAYLOAD DURING THE LAUNCH PHASE. THE STUDY WILL EMPHASIZE SIMPLICITY AND RELIABILITY WHILE DEVELOPING GREATER PAYLOAD CAPACITY FOR THE LAUNCH CONFIGURATION. TWO BASIC TECHNICAL AREAS TO BE STUDIED IN THE ANALYSES ARE: (1) REDUCTION OF THE MEAN WIND SPEED STRUCTURAL LOADS (LOAD REDUCTION) (2) GUST ALLEVIATION (BENDING MODE SUPPRESSION) THE STUDY WILL DEVELOP THE CONTROL LOGIC TO MEET THE LOAD REDUCTION AND GUST ALLEVIATION REQUIREMENTS OF SPACE STATION LAUNCH VEHICLE.

RTOP NO. 125-19-32 TITLE: STUDY OF GUIDANCE AND CONTROL CONCEPTS
FOR APPROACH, HOVER AND TRANSITION OF
VTOL AIRCRAFT IN THE TERMINAL AREA

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, L. TEL. 415-961-1111

TECHNICAL SUMMARY

A DIGITAL ON-BOARD COMPUTER IS INSTALLED IN THE X-14B RESEARCH AIRCRAFT, TO DETERMINE THE APPLICABILITY OF DIGITAL COMPUTATION METHODS TO MODELLING THE FLIGHT CONTROL AND GUIDANCE SYSTEMS FOR ADVANCED VTOL AIRCRAFT. A FLUIDIC EMERGENCY THRUSTER PACKAGE FOR VTOL AIRCRAFT IS BEING DEVELOPED TO PROVIDE CONTROL IN CASE OF PRIMARY SYSTEM FAILURE. AN ANALYSIS OF A FLUIDIC REHEAT THRUSTER CONTROL SYSTEM FOR VTOL APPLICATION IS ALSO BEING CONDUCTED.

RTOP NO. 125-19-35 TITLE: SPACE SHUTTLE - DISPLAY DEVICES

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: HOUSE, S. G. TEL. 713-483-4061

TECHNICAL SUMMARY

TO DEVELOP A CRT HAVING CAPABILITY FOR DIFFERENTIAL COLOR PRESENTATIONS AT HIGH RESOLUTION, WITH LONG-LIFE, HIGH RELIABILITY AND READABLE UNDER ALL LEVELS OF AMBIENT ILLUMINATION.

RTOP NO. 125-21-05 TITLE: PILOT WARNING AND COLLISION HAZARD
RESEARCH

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THE GENERAL OBJECTIVE OF THIS WORK IS THE DEVELOPMENT OF TECHNIQUES WHICH ARE SUITABLE FOR USE BY GENERAL AVIATION AS WELL AS THE AIR CARRIERS FOR THE DETECTION AND PILOT WARNING OF IMPENDING MID-AIR ENCOUNTERS. PRESENT ESTIMATES OF THE NUMBER OF NEAR MISSES IN THE UNITED STATES ARE ON THE ORDER OF 1,000 A YEAR. INDICATIONS ARE THAT THE MAJOR PORTION OF THE PILOT WORKLOAD, AFTER DESCENT FROM CRUISE ALTITUDE, IS THE LOCATION AND AVOIDANCE OF OTHER AIRCRAFT. STATISTICS INDICATE THAT THE PRIMARY HAZARD TO THE AIR CARRIERS IS THE GENERAL AVIATION AIRCRAFT. THE APPROACH UNDER INVESTIGATION IS THE USE OF A CW, DOPPLER SYSTEM OPERATING IN THE MICROWAVE REGION FOR THE MEASUREMENT OF RANGE AND RANGE RATE BETWEEN AIRCRAFT TO EVALUATE THE HAZARD THAT EXISTS. THIS ALLOWS FOR THE DIRECT MEASUREMENT OF THE QUANTITIES OF INTEREST IN THE SIMPLEST FORM ONBOARD THE AIRCRAFT INVOLVED, AND THE DISPLAY OF DERIVED HAZARD INFORMATION TO THE PILOT.

RTOP NO. 125-21-06 TITLE: MICROWAVE NEAR EARTH COMMUNICATIONS AND
TRACKING

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: JOHNSON, C. C. TEL. 301-982-4936

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP WORK AREA IS TO PROVIDE THE TECHNOLOGY FOR IMPROVING ADVANCED COMMUNICATIONS SYSTEMS, SUCH AS ERTS, SPACE STATION, AND TDRS. TO DEVELOP METHODS OF INCORPORATING SOLID STATE ACTIVE DEVICES WHEREVER FEASIBLE IN THE SPACECRAFT AND GROUND STATION EQUIPMENT, AND TO IMPROVE THE ACCURACY AND SENSITIVITY OF THE TRACKING AND DATA SYSTEMS BY PROVIDING AN EFFORT DIRECTED TOWARD FURTHER REFINEMENTS IN NETWORK AND SPACECRAFT PRIMARY FREQUENCY STANDARDS. SINCE THESE ADVANCED SYSTEMS WILL REQUIRE TRANSMISSION DATA RATES AS GREAT AS 100 MEGABITS PER SECOND FROM SEVERAL SIMULTANEOUS USERS, THEY WILL REQUIRE TRANSMITTER-RECEIVER EFFECTIVE BANDWIDTHS ON THE ORDER OF 500 MHZ. ALSO, SINCE SPECTRAL BANDWIDTHS OF THIS MAGNITUDE ARE AVAILABLE ONLY AT FREQUENCIES ABOVE X-BAND, A PORTION OF THIS RTOP WILL BE DEVOTED TO THE DEVELOPMENT OF WIDEBAND KU, K, KA, AND V-BAND COMPONENTS INCLUDING A KU-BAND SOLID STATE TRANSMITTER AND PHASED ARRAY ELECTRONIC ELEMENTS.

RTOP NO. 125-21-09 TITLE: MICROWAVE DEEP SPACE COMMUNICATION AND
TRACKING

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

THE PURPOSE OF THIS ACTIVITY IS TO INCREASE THE COMMUNICATION CAPABILITY AND RELIABILITY OF MICROWAVE LINKS BETWEEN PLANETARY SPACECRAFT AND EARTH DURING THE 1975-1985 PERIOD, BY THE MEANS OF MULTIPLE MISSION SUBSYSTEMS. ONE AREA OF RESEARCH IMPROVES THE

COMMUNICATION CHANNEL BY PROVIDING A GREATER EFFECTIVE POWER GAIN PRODUCT. THE SECOND AREA IMPROVES THE CHANNEL SO PROVIDED BY UTILIZING IT MORE EFFICIENTLY. IN THE FIRST AREA, EFFORT IS DIRECTED TOWARD A MULTIPLE MISSION SPACECRAFT RADIO BLOCK DIAGRAM WITH LONG LIFE, MULTIFREQUENCY OPERATION, AND IMPROVED STABILITY; TOWARD A UNIFIED DUAL FREQUENCY (UDF) DOWNLINK CAPABILITY FOR IMPROVED TRACKING ACCURACY; AND TOWARD THE DEVELOPMENT OF KU-BAND LOW NOISE RECEIVING MASERS TO PROVIDE WIDEBAND RECEIVING CAPABILITY AND INCREASED POWER GAIN. IN THE SECOND AREA, EFFICIENT CHANNEL UTILIZATION, STUDIES OF THE PLANETARY-INTERPLANETARY MEDIUM WILL BE CONTINUED IN ORDER TO PROVIDE BETTER MODULATION AND CODING TECHNIQUES FOR SUCH A CHANNEL; VIKING '75 MUST TRANSMIT THROUGH THE SOLAR CORONA. STRUCTURES SUCH AS CONVOLUTIONAL CODES WILL BE DEMONSTRATED WHICH COME CLOSE TO THE SHANNON LIMIT. BANDWIDTH CONSTRAINED CODING WILL BE ANALYZED SO AS TO PROVIDE MORE USEFUL DATA PER ALLOWED CPS. FINALLY, A SPACECRAFT RANGING CLEAN UP LOOP WILL BE DEMONSTRATED TO PERMIT RAPID RANGING AT OUTER PLANET DISTANCES. A MAJOR EFFORT DURING THE NEXT FEW YEARS IS THE PROVISION OF A DUAL FREQUENCY S-X-BAND ADVANCED TECHNOLOGY EXPERIMENT TO THE MARINER-MERCURY-VENUS '73 SPACECRAFT, IN COOPERATION WITH THE OFFICE OF TRACKING AND DATA ACQUISITION. THIS PROGRAM HAS MANY REQUIREMENTS IN COMMON WITH THE MANNED SPACE STATION MICROWAVE COMMUNICATION SYSTEM, SUCH AS HIGH RELIABILITY, LONG LIFE, AND MULTIFREQUENCY OPERATION, AND CLOSE COORDINATION WILL BE MAINTAINED WITH THAT EFFORT TO AVOID COSTLY DUPLICATION OF RESEARCH AND FACILITIES.

RTOP NO. 125-21-13 TITLE: MANNED SPACE SHUTTLE: ANTENNA TECHNIQUES
AND MATERIALS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP THE CRITICAL TECHNOLOGY REQUIRED FOR DESIGNING ANTENNAS COMPATIBLE WITH THE STRUCTURAL AND THERMAL ENVIRONMENT OF THE SPACE SHUTTLE. ANALYTICAL AND EXPERIMENTAL ANTENNA WORK WILL BE CONDUCTED TO EVALUATE THE PERFORMANCE OF FLUSH MOUNTED ANTENNA ARRAYS COVERED WITH DIELECTRIC MATERIALS. STUDIES WILL BE CONDUCTED TO ASSESS THE POTENTIAL PROBLEM OF ANTENNA BREAKDOWN AND DAMAGE DURING EARTH ENTRY. DURING FY '71 INSTRUMENTATION TECHNIQUES WILL BE DEVELOPED AND TEST PROGRAMS INITIATED TO DETERMINE THE DIELECTRIC PROPERTIES OF CANDIDATE HEAT SHIELD MATERIALS PROPOSED FOR THE SPACE SHUTTLE. ANALYTICAL TECHNIQUES WILL BE EXTENDED TO DETERMINE THE PERFORMANCE OF FLUSH MOUNTED ANTENNAS ON CURVED SURFACES COVERED WITH DIELECTRIC MATERIALS. TECHNIQUES TO MEASURE RF BREAKDOWN WILL BE INVESTIGATED AND CANDIDATE HEAT SHIELD MATERIALS WILL BE TESTED. DURING FY '72 ANALYTICAL AND EXPERIMENTAL WORK WILL CONTINUE. THE RESULTS OF CONTRACTOR PHASE B AND OTHER NASA STUDIES WILL BE REVIEWED TO IDENTIFY ANTENNA DESIGN PROBLEMS. ANTENNA DESIGNS FOR CRITICAL AREAS WILL BE INVESTIGATED AND, WHERE NECESSARY, ENGINEERING ANTENNA MODELS WILL BE DEVELOPED TO EVALUATE PERFORMANCE.

RTOP NO. 125-21-14 TITLE: MANNED SPACE SHUTTLE: MICROWAVE
AMPLIFIERS FOR SPACE SHUTTLE VEHICLE

ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

A C-BAND MICROWAVE ELECTRON TUBE WITH A HIGH OVERALL EFFICIENCY AND RELIABILITY WILL BE DEVELOPED FOR THE COMMUNICATION SUBSYSTEM OF THE SPACE SHUTTLE VEHICLE. THIS TUBE WILL BE COMPATIBLE WITH THE VEHICLE TRANSMITTER USED IN CONJUNCTION WITH THE INTELSAT 4 SATELLITE RELAY COMMUNICATIONS SYSTEM. THE DEVICE WILL HAVE A NOMINAL POWER OUTPUT OF 100 WATTS AND CAN BE USED FOR POWER OUTPUTS IN THE 20 TO 100 WATT RANGE. RESEARCH INVESTIGATIONS WILL BE CONDUCTED FOR EXTENDING THE MICROWAVE TECHNOLOGY TO KU-BAND AND, IF FEASIBLE, DEVICES WILL BE DEVELOPED. DURING FY 71 AN ENGINEERING MODEL OF THE C-BAND MICROWAVE TUBE WILL BE DEVELOPED ON CONTRACT. DEVELOPMENT STUDIES AND LABORATORY INVESTIGATIONS WILL BE CONDUCTED IN-HOUSE TO EXTEND PRESENT TECHNOLOGY TO HIGHER FREQUENCIES. DURING FY 72 THE FINAL SPECIFICATIONS ON THE C-BAND TUBE WILL BE DEVELOPED AND A NUMBER OF FLIGHT QUALIFIED TUBES WILL BE FABRICATED ON CONTRACT FOR PERFORMANCE EVALUATION AND LIFE TESTINGS AT LRC. ALSO, DURING FY 72 DEVELOPMENT CONTRACTS WILL BE INITIATED FOR KU-BAND TRANSMITTING DEVICES

RTOP NO. 125-21-15 TITLE: CODING FOR SPACE STATION COMMUNICATIONS
ORGANIZATION: AMES RESEARCH CENTER

MONITOR: FOSTER, J. V. TEL. 415-961-2267

TECHNICAL SUMMARY

FLIGHT EXPERIENCE ON THE PIONEER PROGRAM HAS DEMONSTRATED THAT ERROR-CORRECTION CODING OF THE TELEMETRY DATA CAN PROVIDE A SUBSTANTIAL SYSTEM GAIN. THIS SYSTEM HAS BEEN USED AT THE LOW DATA RATES ASSOCIATED WITH DEEP SPACE PROBES. EXTENSION OF THESE TECHNIQUES FOR MILITARY APPLICATION HAS DEMONSTRATED SIMILAR GAINS AT DATA RATES OF 5 MBPS. IT IS PROPOSED TO DEVELOP CODING TECHNIQUES FOR SPECIFIC APPLICATION TO COMMUNICATION LINKS FOR A SPACE STATION/BASE PROGRAM WITH DATA RATE REQUIREMENTS GREATER THAN 15 MBPS. DATA CODING WILL INSURE THE EXTREMELY LOW ERROR RATES REQUIRED BY THE INCLUSION OF DATA COMPRESSION TECHNIQUES IN THE LINKS, IN ADDITION TO PROVIDING A SYSTEM GAIN. AN AMES FLIGHT EXPERIMENT, USING CODING, HAS DEMONSTRATED A 3 DB SYSTEM GAIN OVER UNCODED TELEMETRY LINKS USED FOR DEEP SPACE. RECENT EFFORTS INDICATE AN ADDITIONAL 3 TO 4 DB CAN BE GAINED AT THE LOW DATA RATES. SUCH GAINS ARE PARTICULARLY ATTRACTIVE FOR GRAND TOUR MISSIONS. TO FURTHER REDUCE THE PERFORMANCE DIFFERENTIAL BETWEEN ACTUAL SYSTEMS AND THE THEORETICAL LIMIT, THE FOLLOWING CODING RESEARCH TASKS AND SUBSIDIARY STUDIES ARE BEING PURSUED: A. HYBRID CODING TECHNIQUES B. DEVELOPMENT OF SOURCE CODING ALGORITHMS C. CHANNEL CHARACTERIZATION BY ANALYSIS OF PIONEER IX DATA D. PHASE INSTABILITY MEASUREMENT E. PROBABILITY DENSITY FUNCTION GENERATION

RTOP NO. 125-21-16 TITLE: K-BAND COMMUNICATION TECHNOLOGY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THIS EFFORT DEVELOPS ANTENNAS AND RECEIVERS FOR USE ON THE WIDEBAND LINKS OF THE MANNED SPACE STATION. THE ANTENNA TECHNOLOGY IS CONCERNED WITH ERECTABLE ANTENNAS CAPABLE OF OPERATION AT K SUB U-BAND. DESIGNS ARE SOUGHT FOR SEVERAL DIFFERENT GAIN REGIONS. THE ANTENNA WORK WILL BE COORDINATED WITH WORK ON PHASED ARRAYS FOR K SUB U-BAND AT THE GODDARD SFC UNDER RTOP 908-52-07, AND WITH JPL WORK ON MULTIPLE BEAM ANTENNAS UNDER 164-21-54. TO SUPPORT THE ANTENNA RESEARCH, AS WELL AS THE ENTIRE K SUB U-BAND EFFORT FOR THE MANNED SPACE STATION, THE VOLTAGE BREAKDOWN THEORY DEVELOPED FOR LOWER FREQUENCIES WILL BE EXTENDED INTO THIS REGION. THE RECEIVER EFFORT UNDER THIS RTOP IS CONCERNED WITH DEVELOPING A WIDEBAND LOW-NOISE PREAMPLIFIER AS AN ALTERNATE BACKUP TO THE PARAMP BEING DEVELOPED BY GODDARD SPACE FLIGHT CENTER FOR THE OTDA TDRSN PROGRAM, AND AS A POSSIBLE SECOND STAGE TO THAT PARAMP. WORK ON K SUB U-BAND TRANSMITTERS AND RECEIVERS UNDER GODDARD RTOP 125-21-06 WILL BE FOLLOWED CLOSELY. JPL IS DEVELOPING TECHNOLOGY FOR LOW-NOISE K SUB U-BAND RECEIVING MASERS UNDER RTOP 125-21-09. A COMPANION JPL RTOP, 125-21-18, DEVELOPS SUBSYSTEM TECHNOLOGY FOR THE MANNED SPACE STATION MICROWAVE COMMUNICATION SYSTEM.

RTOP NO. 125-21-17 TITLE: SPACE SHUTTLE LOW NOISE RECEIVER
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: JOHNSON, C. C. TEL. 301-982-4936
TECHNICAL SUMMARY

THE SPACE SHUTTLE COMMUNICATION THROUGH GEOCENTRIC SATELLITES WILL REQUIRE INCREASED ANTENNA SIZES OR MORE SENSITIVE RECEIVING SYSTEMS. SINCE RE-ENTRY IS A FACTOR, IT IS OBVIOUS THAT THE LATTER AREA OF CONCERN SHOULD BE DEVELOPED. THIS RTOP WILL DEVELOP A SPACE QUALIFIED PARAMP TECHNOLOGY AT C-BAND AND K SUB U BAND. THE C-BAND PARAMP WILL HAVE A NOISE FIGURE OF LESS THAN 2 DB AND THEREBY SIGNIFICANTLY REDUCE THE SIZE REQUIREMENT OF THE ANTENNA. THIS EFFORT WILL BE PRIMARILY CONTRACTUAL WITH SOME EFFORT PERFORMED IN-HOUSE. THE C-BAND UNIT MUST BE DEVELOPED COMPLETELY, WHEREAS THE PROTOTYPE K SUB UNIT WILL BE DEVELOPED FOR THE TDRS PROGRAM. THIS PROTOTYPE MUST THEN BE DEVELOPED THROUGH THE SPACE QUALIFICATION SEGMENT.

RTOP NO. 125-21-18 TITLE: MICROWAVE COMMUNICATION FOR THE MANNED
SPACE STATION
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE EFFORT UNDER THIS RTOP IS DIRECTED TOWARD DEVISING SUBSYSTEMS FOR THE UNIFIED MICROWAVE COMMUNICATION SYSTEM OF THE MANNED SPACE STATION. NEW REQUIREMENTS THAT THE SPACE STATION PUTS UPON SUCH COMMUNICATION SUBSYSTEMS INCLUDE THE REQUIREMENT FOR HIGH

RELIABILITY COUPLED WITH LONG LIFE; THE SIMULTANEOUS USE OF MANY FREQUENCIES; THE PRESENCE OF MANY DIFFERENT TYPES OF SIGNAL SOURCES; THE NEED TO COMMUNICATE TO MANY MODULES AT ONCE; THE HEAVY USE OF RELAY COMMUNICATIONS, INCLUDING USE OF THE TRACKING DATA RELAY SATELLITE NETWORK (TDRSN); AND EXTREMELY HIGH DATA RATES AND WIDE BANDWIDTHS. HOWEVER, TO AVOID COSTLY DUPLICATION OF EFFORT, THE MULTIPLE MISSION APPROACH IS STRESSED WHERE POSSIBLE. PARTICULAR SUBSYSTEMS BEING INVESTIGATED IN THIS RTOP INCLUDE THE MODULATION/DETECTION SUBSYSTEM FOR BOTH TELEMETRY AND COMMAND, AND THE RADIO SUBSYSTEM, INCLUDING LONG LIFE TRANSMITTERS AND WIDEBAND RECEIVERS. IN THE COMMAND AREA, THE GOAL IS A SMALL, EFFICIENT, RELIABLE COMMAND DETECTOR THAT PERMITS RAPID ACQUISITION AND VARIABLE RATES. IN THE TELEMETRY AREA, THE GOAL IS TO PROVIDE EFFICIENT DEMODULATION TECHNIQUES FOR BOTH CARRIER AND SUBCARRIER, SO THAT TRANSMITTER POWER AND ANTENNA GAINS CAN REMAIN SMALL ENOUGH FOR USE ON ALL MODULES OF THE STATION. IN ADDITION, THE GOAL IS TO PROVIDE READILY VARIABLE MODULATION INDICES SO THAT THE SAME MODULATION SUBSYSTEM CAN BE USED WITH ONLY MINOR CHANGES IN DIFFERENT MODULES OF THE SPACE STATION. IN THE TRANSMITTER AREA, THE GOAL IS A LONG-LIFE TRANSMITTER USING AUTOMATIC CATHODE REPLACEMENT. IN THE RECEIVER AREA, THE GOAL IS A WIDEBAND RECEIVER OF FROM 100 MHZ TO 500 MHZ BANDWIDTH WITH HIGH STABILITY SO THAT DATA QUALITY IS NOT DEGRADED IN RELAY OPERATION. THIS WORK RELIES UPON JPL WORK ON RTOP 125-21-16, WHICH DEVELOPS K SUB U-BAND ANTENNAS AND LOW-NOISE PREAMPLIFIERS FOR THE SPACE STATION.

RTOP NO. 125-21-21 TITLE: RAM C-C
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: DRALEY, E. C. TEL. 703-827-3285
TECHNICAL SUMMARY

RAM C-C WILL OBTAIN PLASMA DIAGNOSTIC DATA ON THE REENTRY FLOW FIELD AND WILL TEST THE RELATIVE EFFECTIVENESS OF WATER AND AN ELECTROPHILIC LIQUID ADDITIVE AS A MEANS OF ALLEVIATING RADIO COMMUNICATIONS BLACKOUT. CONTRACTUAL STUDIES WILL BE REQUIRED TO COMPLETE THE RAM FLIGHT DATA ANALYSIS.

RTOP NO. 125-22-04 TITLE: LARGE TELESCOPE TECHNOLOGY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: MANGUS, J. D. TEL. 301-982-5501
TECHNICAL SUMMARY

A TELESCOPE TECHNOLOGY PROGRAM IS TO BE CONDUCTED USING IN-HOUSE AND CONTRACT RESOURCES TO DEVELOP THE TECHNOLOGY (WITH-IN FUNDING CONSTRAINTS) REQUIRED TO CONSTRUCT A LARGE (IN THE ORDER OF 120-INCH DIAMETER APERTURE) SPACE-BORNE OPTICAL TELESCOPES, THE PERFORMANCE OF WHICH ARE LIMITED ONLY BY DIFFRACTION AND/OR THE STATISTICAL NOISE OF THE RADIATION RECEIVERS IN THE ACCESSORY EQUIPMENT. SOLUTION OF TECHNOLOGICAL PROBLEMS WHICH MUST BE ADDRESSED TO REALIZE THE ABOVE GOAL ARE THE DETERMINATION OF PARAMETERS AND TECHNIQUES AS RELATED TO THE DESIGN, FABRICATION AND CONSTRUCTION OF A TELESCOPE IN A ONE "G" GROUND BASED ENVIRONMENT, SUBSEQUENTLY SUBJECTING IT TO A SEVERAL "G"

LAUNCH ENVIRONMENT, AND FINALLY OPERATING IN A DIFFRACTION LIMITED MODE IN A ZERO "G" SPACE ENVIRONMENT. THEREFORE, THE WIDE VARIETY OF FACTORS ASSOCIATED WITH EACH ENVIRONMENT THAT COULD ADVERSELY EFFECT THE TELESCOPE PERFORMANCE MUST BE CONSIDERED AS COMPREHENSIVELY AS POSSIBLE THROUGHOUT THE RESEARCH PROGRAM. TO MAKE A JUDGMENT ON REALIZING THE ABOVE GOAL IT IS MOST IMPORTANT TO INITIALLY INVESTIGATE FACTORS OF THE FIRST ORDER EFFECTING A POSITIVE DECISION.

THEREFORE, A COMPREHENSIVE PROGRAM IS TO BE CONTINUED WHICH DOCUMENTS, CONDUCTS AND PRESERVES IN THE LABORATORY WHERE NECESSARY THOSE TECHNOLOGICAL DEVELOPMENTS AND PROCEDURES REQUIRED TO MEET THE OVERALL PROGRAM GOAL. THIS PROGRAM WILL COMPLEMENT THE PRESENT EFFORT AT GSFC IN OPTICAL COATING TECHNOLOGY, EXTEND THE PRESENT OPTICAL COMPONENT DEVELOPMENT TO WAVELENGTHS GREATER THAN 900 ANGSTROMS AND CONTINUE COOPERATIVE EFFORTS BETWEEN GSFC AND MSFC AS PRESENTLY DEMONSTRATED ON THE GSFC X-RAY TELESCOPE INSTRUMENT ON ATM. ADDITIONALLY, THE WORK AT LRC WILL SERVE AS INPUT TO THIS RTOP.

RTOP NO. 125-22-05 TITLE: SPACE STATION OPTICAL COMPONENTS AND TECHNOLOGY

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: PLOTKIN, H. H. TEL. 301-982-5503

TECHNICAL SUMMARY

OBJECTIVE IS TO DEVELOP EFFICIENT SYSTEMS FOR WIDE-BAND OPTICAL COMMUNICATION AND PRECISION TRACKING, SUITABLE FOR NASA SPACE STATION PROGRAM. TECHNIQUES AND SUBSYSTEMS WILL ALSO BE EXTENDED TO APPLICATIONS IN DEEP SPACE, EARTH RESOURCES, AND DATA RELAY MISSIONS.

TARGET REQUIREMENTS ARE ASSUMED TO BE COMMUNICATION LINKS BETWEEN (SPACE STATION AND SPACE BASE OR APPLICATION) SATELLITES, WITH CAPACITY OF 300 MEGABITS/SEC., DEVELOPED ON TIME SCALE COMPATIBLE WITH EARLIEST SPACE STATION MISSIONS. CAPACITY FOR COMMUNICATING DIRECTLY WITH GROUND STATION WILL ALSO BE STUDIED. PRIMARY EFFORT WILL BE DEVELOPMENT OF SYSTEMS AND COMPONENTS FOR ND:YAG LASERS (NEODYMIUMDOPED CRYSTALS OF YTTRIUM-ALUMINUM GARNET). SUCH SYSTEMS SHOW PROMISE FOR PROVIDING DIGITAL COMMUNICATION WITH VERY HIGH DATA RATES USING LOW POWER TRANSMITTERS AND RECEIVERS, LOW WEIGHT, SMALL ANTENNAS, AND NEGLIGIBLE INTERFERENCE, AND SPECTRUM CROWDING. IN FY71, TRANSMITTER DEVELOPMENT INITIATED AT ERC WILL BE CONTINUED AND AUGMENTED TO INCLUDE DEVELOPMENT OF LOW THRESHOLD EFFICIENT DIODE LASER OPTICAL PUMPING AND SPACE QUALIFICATION. COMPONENT RESEARCH WILL ALSO INCLUDE FREQUENCY DOUBLING TECHNIQUES, HIGH DATA RATE DIGITAL MODULATORS, VERY FAST DETECTORS AT BOTH 10.6 AND 0.53 MICROMETERS, AND DIGITAL CIRCUITRY FOR SYNCHRONOUS DETECTION AND SIGNAL PROCESSING. BREADBOARD SYSTEMS WILL BE ASSEMBLED, TESTED AT GODDARD OPTICAL RESEARCH FACILITY, EMPLOYED IN ATMOSPHERIC AND MULTI-PATH TESTS, AND USED IN ATMOSPHERIC AND MULTI-PATH TESTS, AND USED IN PASSIVE TRACKING STUDIES AGAINST AIRPLANES AND SATELLITES. FROM THIS EXPERIMENT, EXPERIMENTS AND APPLICATIONS IN SPACE-TO-SPACE AND SPACE-TO-GROUND MISSIONS WILL BE PROPOSED AND DEVELOPED.

RTOP NO. 125-22-06 TITLE: OPTICAL TECHNOLOGY TEST AND OPERATION
STATION (OTTOS)

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: PLOTKIN, H. H. TEL. 301-982-5503

TECHNICAL SUMMARY

OPTICAL TECHNOLOGY IS BEING ADVANCED THROUGH VARIOUS RESEARCH AND DEVELOPMENT TASK THROUGHOUT NASA. THESE PROGRAMS WILL PROGRESS FROM THE LABORATORY, TO FIELD CHECK-OUT TO OPERATIONAL MISSIONS. THIS RTOP IS FOR ESTABLISHING A COOPERATIVE EFFORT BETWEEN NASA AND THE SMITHSONIAN ASTRONOMICAL OBSERVATORY WHEREBY NASA EXPERIMENTERS CAN USE THE SAO'S SITE AT MOUNT HOPKINS ARIZONA FOR CARRYING OUT FIELD EXPERIMENTS AND OPERATION IN AN AREA HAVING EXCELLENT "SEEING" CONDITIONS. OBSERVATIONAL AND OPTICAL COMMUNICATION TECHNIQUES DEVELOPED AND/OR EVALUATED AT THE SITE WILL BE USED TO DEVELOP OPTICAL COMMUNICATION SYSTEMS FOR USE IN NASA SPACE STATION PROGRAMS.

RTOP NO. 125-22-08 TITLE: OPTICAL COMMUNICATIONS AND TRACKING

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: PLOTKIN, H. H. TEL. 301-982-5503

TECHNICAL SUMMARY

PROGRAM CONDUCTS STUDIES AND DEVELOPS TECHNOLOGY OF COMPONENTS, SYSTEMS, AND OPERATIONAL TECHNIQUES FOR SPACECRAFT COMMUNICATION AND TRACKING WITH LASERS. OPTICAL TECHNOLOGY IS DIRECTED TOWARD SATISFYING NASA'S NEED FOR PRECISION TRACKING AND HIGH DATA RATE COMMUNICATION IN THE 1970 TO 1985 ERA. USING LATEST DEVELOPMENTS FROM CONTINUOUSLY CHANGING STATE-OF-THE-ART PROOF-OF-CONCEPT MODELS OF LASER TRANSMITTERS, RECEIVERS, MODULATORS, AND TELESCOPES, ARE DESIGNED AND CONSTRUCTED. PERFORMANCE OF COMPONENTS AND SYSTEMS IS MEASURED IN LABORATORY AND FIELD STATIONS UNDER CONDITIONS IN WHICH EFFECTS OF ENVIRONMENTAL PERTURBATIONS SUCH AS ATMOSPHERIC PROPAGATION, ACOUSTIC VIBRATION, AND SOLAR RADIATION BACKGROUND CAN BE STUDIED, LEADING TO THEORETICAL SYSTEMS ANALYSIS AND SELECTION OF OPTIMUM COMPONENTS AND PARAMETERS. PROTOTYPE TRACKING AND COMMUNICATION TERMINALS ARE DEVELOPED AND EMPLOYED IN EXPERIMENTS WITH SATELLITE EQUIPMENT SUCH AS PASSIVE REFLECTORS, LASER DETECTORS, AND RADIATING SOURCES, IN ORDER TO PROVE CONCEPTS AND PROVIDE BASELINE DATA FOR SPECIFIC APPLICATION DESIGNS. GSFC EMPHASIS IS ON DEVELOPMENT AND EVALUATION OF COMPLETE OPERATIONAL SYSTEMS NEEDED FOR SPACE LASER APPLICATIONS. FUNDAMENTAL RESEARCH IN MATERIALS AND DEVICES, COMPONENT OPERATIONS, CONTROL SYSTEMS, AND ENVIRONMENTAL PROPERTIES ARE PERFORMED WHEN NECESSARY FOR DIRECT SUPPORT OF SYSTEM DEVELOPMENT, TEST, AND ANALYSIS.

RTOP NO. 125-22-09 TITLE: FLIGHT TEST OF LARGE TELESCOPE

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

THIS RESEARCH PROGRAM IS DESIGNED TO DEVELOP A FLIGHT PROJECT FOR THE SPACE STATION TO PROVE THE CONCEPT OF THE TECHNOLOGY NEEDED FOR A THREE METER DIFFRACTION LIMITED OPTICAL SPACE TELESCOPE.

SPECIFICALLY THIS PROGRAM WILL LEAD TO A FULLY OPERATIONAL ORBITING NATIONAL ASTRONOMICAL SPACE OBSERVATORY (NASO) IN THE EARLY 1980'S. IN PREPARATION FOR THIS, MSFC AND OTHER NASA ELEMENTS, IN COOPERATION WITH MEMBERS OF THE ASTRONOMICAL COMMUNITY, HAVE DEFINED A SET OF PROOF OF CONCEPT ACTIVITIES WHICH SHOULD GUARANTEE THE AVAILABILITY OF NECESSARY TECHNOLOGY TO MAKE THE NASO A PRACTICAL VENTURE. THE PROOF OF CONCEPT ACTIVITIES HAVE BEEN CATEGORIZED AS TO METHOD OF EXPERIMENTAL SOLUTION SUCH AS EARTH LABORATORY, AIRCRAFT OR BALLOON, AND TRUE SPACE FLOWN EXPERIMENTS. AS MANY INDIVIDUAL CONCEPT ELEMENTS AS IS ECONOMICALLY FEASIBLE WILL BE SPACE TESTED AS EARLY IN THE PROGRAM AS POSSIBLE. IT IS PLANNED IN THE COMING YEAR TO DEVELOP TECHNOLOGIES THAT ARE REQUIRED TO FULFILL THE FLIGHT PROGRAM. THIS TECHNOLOGY PROGRAM WILL INCLUDE THE DEVELOPMENT OF PRECISION REAL TIME FIGURE SENSORS FOR MEASUREMENT OF MIRROR SURFACES, BOTH PASSIVE AND ACTIVE; THE DEVELOPMENT OF COMPUTER CONTROL OF ACTIVE MIRRORS IN REAL TIME, AND START OF THE DEVELOPMENT OF A BREADBOARD FLIGHT TELESCOPE SYSTEM. COMPONENTS OF THIS TECHNOLOGY DEVELOPMENT WILL BE PURCHASED ON CONTRACT WITH ALL OF THE INTEGRATION AND SYSTEM PERFORMANCE EVALUATION BEING PERFORMED INHOUSE AT MSFC.

RTOP NO. 125-22-10 TITLE: OPTICAL COMMUNICATION TECHNOLOGY
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

THIS RESEARCH PROGRAM IS DESIGNED TO PROVE THE CONCEPT OF COMMUNICATION FROM SPACE TO SPACE AND SPACE TO EARTH, UTILIZING THE UNIQUE POTENTIAL OF THE OPTICAL PORTION OF THE ELECTROMAGNETIC SPECTRUM. THE NECESSARY TECHNOLOGY BASE WILL BE ESTABLISHED TO PERMIT OPERATIONAL OPTICAL COMMUNICATION SYSTEMS TO BE EMPLOYED IN THE 1975 TO 1980 TIME PERIOD. BOTH NEAR EARTH SPACE TO GROUND AND SPACE TO SPACE APPLICATIONS AND DEEP SPACE TO EARTH APPLICATIONS APPEAR ATTRACTIVE AND TECHNICALLY FEASIBLE. THIS PROGRAM IS AIMED AT DETERMINING THE PRACTICAL ASPECTS AND LIMITS OF SUCH TECHNIQUES THROUGH AN ORDERLY SERIES OF FLIGHT TESTS AND CRITICAL COMPONENT AND TECHNOLOGY R&D IN ORDER TO MAKE THIS TECHNOLOGY READY FOR OPERATIONAL COMMITMENTS. THE FIRST PHASE OF THE FLIGHT PROGRAM CONSISTS OF A SERIES OF HIGH ALTITUDE AIRCRAFT OPTICAL COMMUNICATION TESTS TO A GROUND STATION LOCATED AT MSFC. THE AIRCRAFT WILL BE EITHER AN RB-57 OR U-2 TYPE AIRCRAFT. EACH PACKAGE WILL BE FLOWN OVER THE MSFC GROUND STATION FOR SEVERAL HOURS AT ALTITUDES VARYING FROM 50,000 TO 70,000 FT. UNDER VARYING ATMOSPHERIC CONDITIONS TO DETERMINE THE TURBULENCE AND CLOUD EFFECTS ON THE UP AND DOWN LASER BEAM. TESTS WILL BEGIN IN MAY 1971. DURING THE FY71 YEAR IT IS PLANNED TO BEGIN A PROGRAM PLAN FOR THE SATELLITE FLIGHT TEST PROGRAM WHICH WOULD BEGIN IN FY72. THIS PROGRAM PLAN WILL BE DEVELOPED.

RTOP NO. 125-22-14 TITLE: ADVANCED OPTICAL COMMUNICATION RESEARCH
ORGANIZATION: NASA HEADQUARTERS
MONITOR: MESON, J. K. TEL. 202-962-7335
TECHNICAL SUMMARY

THIS PROGRAM OF RESEARCH IS DIRECTED TOWARDS PROVIDING NASA WITH FUNDAMENTAL TOOLS AND METHODS OF OPTICAL COMMUNICATION AT DEEP SPACE AND INTERPLANETARY DISTANCES FOR MISSIONS IN THE 1970 - 1985 TIME PERIOD. THE FUTURE REQUIREMENTS FOR WIDE BAND, HIGH DATA RATE COMMUNICATION CAN BEST BE SATISFIED BY OPTICAL SYSTEMS USING LASER TECHNOLOGY. THE PRESENT PROGRAM WILL ADVANCE THE STATE-OF-ART TECHNOLOGY BY MEANS OF TWO GRANTS FOR RESEARCH IN LASER TRANSMITTERS, MODULATORS, RECEIVERS AND OPTIMAL COMMUNICATION TECHNIQUES, AND WILL COMPLEMENT RELATED RESEARCH AND DEVELOPMENT AT NASA FIELD CENTERS.

RTOP NO. 125-23-05 TITLE: SPACE STATION/BASE: BATCH-FABRICATED
MAGNETIC TECHNIQUES FOR ONBOARD DATA
SYSTEMS

ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-3285
TECHNICAL SUMMARY

A RECOGNIZED NEED OF THE SPACE STATION/BASE IS AN INTEGRATED ELECTRONIC SYSTEM, CONSISTING IN PART, OF A HIGHLY RELIABLE COMPUTER SYSTEM. INHERENT TO THE DESIGN OF THE INTEGRATED ELECTRONIC SYSTEM WILL BE A FAMILY OF DIGITAL LOGIC MODULES FOR USE AS BUILDING BLOCKS OF THE SYSTEM. IN THE EFFORT TO REALIZE ULTRA-RELIABLE SYSTEMS, ADVANTAGE WILL BE TAKEN OF THE SUPERIOR INHERENT RELIABILITY OF FERRITE MATERIALS AND BATCH FABRICATION TECHNIQUES. RESEARCH PRESENTLY UNDERWAY WILL BE EXPEDITED ON FERRITE MATERIAL COMPOSITION, MATERIALS SYNTHESIS, AND PROCESSING TECHNIQUES TO DEFINE BATCH FABRICATION METHODS. MAGNETIC DEVICES, CIRCUITS, AND SUBSYSTEM CONFIGURATIONS MOST CAPABLE OF PROVIDING ULTRA-RELIABLE PERFORMANCE IN COMPUTERS, SEQUENCERS, AND DATA SYSTEMS WILL BE INVESTIGATED, THEIR TECHNICAL FEASIBILITY ESTABLISHED, AND PERFORMANCE DEMONSTRATED.

RTOP NO. 125-23-10 TITLE: SPACE STATION/BASE AUTOMATED DATA
HANDLING TECHNIQUES AND COMPONENTS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: SCHAEFER, D. H. TEL. 301-982-5184
TECHNICAL SUMMARY

IN ACCOMPLISHING ANY SOPHISTICATED SPACECRAFT MISSION IN THE FUTURE, AND IN PARTICULAR IN ACCOMPLISHING THE OBJECTIVES OF SPACE STATION/SPACE BASE, NASA WILL BE CONFRONTED WITH THE PROBLEM OF EVER INCREASING DATA VOLUME. THERE IS A RAPIDLY INCREASING NEED FOR SOPHISTICATED TECHNIQUES FOR DATA HANDLING AND RAPID AUTOMATIC DATA ANALYSIS BOTH ON-BOARD AND ON THE GROUND. FOUR AREAS NEED TO BE SIMULTANEOUSLY EXPLORED: 1) MODELING OF SPACE STATION/SPACE BASE DATA GENERATING SUBSYSTEMS AND ON-BOARD DATA PROCESSING SYSTEMS. THIS IS NECESSARY IN ORDER TO ENVISION THE TYPE AND QUANTITY OF DATA GENERATED ABOARD THE SPACECRAFT AND TO EVALUATE THE EFFECTS OF VARIOUS TECHNIQUES OF PROCESSING THIS DATA, 2) DEVELOPMENT OF

MICROPROCESSOR ELECTRONICS TO MAKE POSSIBLE A MULTIPLICITY OF SMALL PERIPHERAL COMPUTERS SCATTERED THROUGHOUT THE SPACE STATION FOR CONTROLLING AND PRE-PROCESSING DATA FROM INDIVIDUAL SENSORS OR EXPERIMENTS. IN ORDER TO PRODUCE THESE MICROPROCESSORS, BOTH SEMICONDUCTOR AND OPTICAL TECHNOLOGY MUST BE DEVELOPED, 3) DEVELOPMENT OF GENERAL PURPOSE PATTERN RECOGNITION CIRCUITRY FOR MAKING CLASSIFICATIONS AND DECISIONS CONCERNING SPACE STATION DATA IN ORDER TO OPTIMIZE DATA PROCESSING AND TO IMPLEMENT REAL TIME CONTROL COMMANDS, 4) DEVELOPMENT OF OPTIMUM METHODS OF INFORMATION TRANSMITTAL BOTH WITHIN THE STATION AND TO THE GROUND.

RTOP NO. 125-23-12 TITLE: ADVANCED DIGITAL DATA SYSTEMS FOR DEEP SPACE

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

THE GOAL OF THIS PLAN IS TO PROVIDE CONCEPTUAL TOOLS AND TECHNOLOGY NEEDED FOR THE EVENTUAL DESIGN AND CONSTRUCTION OF CENTRALIZED DATA SYSTEMS FOR LONG-LIVED, VERSATILE, ADAPTABLE INTERPLANETARY SPACECRAFT. THE WORK IS MOTIVATED PRINCIPALLY BY THE REQUIREMENTS OF EXPECTED MISSION TO THE OUTER PLANETS OF THE SOLAR SYSTEM, FOR EXAMPLE THE GRAND TOUR, AND DIRECTLY SUPPORTS A LABORATORY-WIDE STUDY OF A SPECIFIC SPACECRAFT FOR SUCH A MISSION (TOPS - THERMOELECTRIC OUTER PLANET SPACECRAFT), ALTHOUGH THE RESULTS WILL BENEFIT OTHER NASA PROGRAMS AS WELL. MAJOR PROBLEMS TO BE ADDRESSED ARE: 1) HOW TO ORGANIZE COMPLEX DATA SYSTEMS THAT ARE SUFFICIENTLY RELIABLE TO GUARANTEE PERFORMANCE OF ALL CRITICAL FUNCTIONS FOR PERIODS OF 10-20 YEARS, DESPITE SUBSYSTEM FAILURES, YET SUFFICIENTLY FLEXIBLE TO PROVIDE FOR AUTOMATIC ON-BOARD ADAPTATION TO CHANGES IN ENVIRONMENT, OR FOR RECONFIGURATION OF THE SPACECRAFT SUBSYSTEMS BY GROUND COMMAND TO ACCOMMODATE CHANGES IN SCIENTIFIC STRATEGY OR EMPHASIS DURING THE LONG LIFE OF THE MISSION; 2) HOW TO DESIGN AND BUILD DIGITAL SUBSYSTEMS EFFICIENTLY, SO THAT UNNECESSARY COMPLEXITY AND REDUNDANCY HAVE BEEN REMOVED, BUT SO THAT ADEQUATE PROVISION HAS BEEN MADE FOR ERROR DETECTION AND DIAGNOSIS OR FAULT MASKING TO INSURE RELIABLE PERFORMANCE; 3) HOW TO MEET THE NEEDS FOR HIGH DENSITY, LOW WEIGHT, LOW POWER, LOW COST LOGIC, MEMORIES, AND RECORDERS THAT ARE INSENSITIVE TO RADIATION AND TEMPERATURE EXTREMES, AND RELATIVELY FREE FROM LONG TERM DEGRADATION IN THEIR PHYSICAL AND ELECTRICAL PROPERTIES.

RTOP NO. 125-23-14 TITLE: SPACE STATION - ONBOARD CHECKOUT

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: HUGHES, J. F. TEL. 713-483-4162

TECHNICAL SUMMARY

THE OBJECTIVES OF THESE TASKS ARE THE DEVELOPMENT OF TECHNIQUES AND STRATEGIES FOR AUTOMATED STATUS MONITORING OF ALL CHECK POINTS PROVIDED AT SUBSYSTEMS INTERFACES, LIFE SUPPORT, POWER, PROPULSION, ETC. AUTOMATED TECHNIQUES OF ASSESSING SUBSYSTEM PERFORMANCE FOR MAINTENANCE PROVISIONS WILL BE DEVELOPED TO ESTABLISH CONSTRAINTS AND

GUIDELINES FOR SUBSYSTEMS DESIGN AND DEVELOPMENT. PARTICULAR EMPHASIS WILL BE GIVEN TO THE ASSESSMENT OF OPERATIONAL STATUS OF AN INTEGRATED ELECTRONIC SYSTEM.

RTOP NO. 125-23-15 TITLE: SPACE STATION - CENTRAL MULTIPROCESSOR
AND MAN/MACHINE TECHNIQUES

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: HUGHES, J. F. TEL. 713-483-4065

TECHNICAL SUMMARY

THE PRESENT CONCEPTS OF A SPACE STATION/BASE AS A PERMANENT FACILITY (10 YEAR LIFE) IMPLIES SELF-CONTAINED AUTONOMOUS OPERATIONS.

THIS REQUIRES PERFORMING ON-BOARD FUNCTIONS WHICH WERE PREVIOUSLY PERFORMED ON THE GROUND SUCH AS STATUSING OPERATIONS, INTEGRATED SUBSYSTEM CHECKOUT, PROCESS CONTROL, AND SCIENTIFIC DATA EDITING AND PROCESSING. THE ON-BOARD COMPUTATIONAL CAPACITY REQUIRED TO ACCOMPLISH THESE FUNCTIONS ON-BOARD GREATLY EXCEEDS ANY PREVIOUS FLIGHT COMPUTATIONAL REQUIREMENTS. THE DESIGN AND DEVELOPMENT OF A HIGH CAPACITY, HIGH SPEED, FAULT TOLERANT, SPACE FLIGHT MULTIPROCESSOR COMPUTER SYSTEM TO PERFORM THE ON-BOARD COMPUTATIONS IS RECOGNIZED AS A CRITICAL TECHNOLOGY AREA. TO ASSUME THE AVAILABILITY OF THIS CRITICAL TECHNOLOGY, THIS EFFORT WILL RESULT IN THE DEVELOPMENT OF MAN/MACHINE M/P COMMUNICATIONS TECHNIQUES, THE DESIGN OF AN AEROSPACE MULTIPROCESSOR, AND THE AVAILABILITY OF MULTICOMPUTER SYSTEM FOR IN-HOUSE EVALUATION OF PRELIMINARY MULTIPROCESSOR CONCEPTS AND APPLICATIONS.

RTOP NO. 125-23-16 TITLE: SPACE STATION OPTICAL MASS MEMORY SYSTEM

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

A MASS MEMORY SYSTEM IS REQUIRED FOR THE SPACE STATION/SPACE BASE SYSTEM OF 1976 THAT DWARFS EXISTING SYSTEMS IN TERMS OF CAPACITY, SPEED, POWER REQUIREMENTS, SIZE, ETC. IT IS TO BE A 10 TO THE 12TH POWER BIT SYSTEM WITH ACCESS TIMES IN HUNDREDS OF NANO-SECONDS. FOR MEMORIES OF THIS CAPACITY, TO KEEP OTHER PARAMETERS REASONABLE, OPTICAL TECHNIQUES WILL BE EMPLOYED, DEPENDING FIRST ON THE PROPER CHOICE OF MEMORY ELEMENT, AND SECOND ON THE ACCESSION SYSTEM. INCLUDED IN THIS WORK HAS BEEN ELECTRO-OPTICS, ACOUSTO-OPTICS, BIREFRINGENT DEFLECTION, PIEZOELECTRIC REFRACTION AND REFLECTION, AND MECHANICAL DEFLECTION. CRITICAL PARAMETERS TO BE OPTIMIZED INCLUDE RAPID DEFLECTION, LOW LIGHT LOSS, LOW OPTICAL-PHASE FRONT DISTORTION, HIGH DEFLECTION ACCURACY, AND MODERATELY LARGE LIGHT-POWER-HANDLING CAPABILITY. THE MAGNETO-OPTIC PROPERTIES OF FERROMAGNETIC, FERRIMAGNETIC MATERIALS AND FERROELECTRIC MATERIALS, AS WELL AS PHOTOCHROMIC MATERIALS AND HOLOGRAPHY, HAVE BEEN STUDIED AS CANDIDATES FOR LARGE CAPACITY STORAGE. THE CRITICAL PARAMETERS INVOLVED IN THE MEMORY ELEMENT INCLUDE EXTREMELY SMALL SIZE, LOW POWER ABSORPTION, FAST RESPONSE, READ ALTERABLE, BIT ISOLATION, STABILITY AND NON-VOLATILITY.

RTOP NO. 125-23-17 TITLE: FAULT TOLERANT COMPUTER FOR THE SPACE
STATION

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6856

TECHNICAL SUMMARY

THE GOAL OF THE WORK INCLUDED IN THIS PLAN IS THE DEVELOPMENT OF THE TECHNOLOGY REQUIRED TO DESIGN AND BUILD A DIGITAL COMPUTER WITH GENERAL PURPOSE CAPABILITIES WHICH WILL SURVIVE THROUGH A MISSION LIFETIME IN EXCESS OF TEN YEARS AND TO STUDY AND DEVELOP THE APPLICATION OF THIS COMPUTER TO THE PROBLEMS OF AUTOMATIC CHECKOUT AND AUTOMATIC MAINTENANCE. THIS DEVELOPMENT IS SPECIFICALLY AIMED AT THE PROBLEM OF AUTOMATIC CHECKOUT IN THE SPACE STATION. THE MACHINE CAPABILITIES WILL ALSO BE TAILORED SO THAT IT WILL HAVE THE CAPABILITY OF ACTING AS A GUIDANCE COMPUTER IN EMERGENCIES. THE MAJOR PROBLEMS IN MEETING THIS GOAL ARE TO PROVIDE SUFFICIENT RELIABILITY TO GUARANTEE FAILURE-FREE OPERATION OVER THE TIME PERIOD REQUIRED AND TO PROVIDE SUFFICIENT FLEXIBILITY TO PERMIT AUTOMATIC ON-BOARD ADAPTATION TO CHANGING ENVIRONMENT AS THE MISSION PROGRESSES. IT IS EXPECTED THAT SUCH A COMPUTER AND THE STRATEGIES DEVELOPED WILL HAVE APPLICATION IN OTHER NASA PROGRAMS AS WELL AS IN FIELDS OUTSIDE THE SPACE PROGRAM WHERE A HIGHLY RELIABLE DIGITAL COMPUTER IS NEEDED. THE BASIC ELEMENTS OF THE TECHNICAL PLAN FOR FY 71 ARE: (1) CONTINUE THE INVESTIGATION OF TECHNIQUES FOR IMPROVING THE RELIABILITY OF DIGITAL COMPUTERS BY USE OF REPLACEMENT REDUNDANCY AND SELF-TESTING. RELIABILITY INCLUDES (A) ON A LONG-TERM BASIS, THE MACHINE WILL CONTINUE TO OPERATE, AND (B) ON A SHORT-TERM BASIS IT HAS A LOW PROBABILITY OF ISSUING FALSE COMMANDS BECAUSE OF TRANSIENT ERRORS. (2) CONTINUE DEVELOPMENT AND CONSTRUCTION OF THE RESEARCH BREADBOARD OF THE SELF-TESTING-AND-REPAIRING (STAR) COMPUTER. (3) CONTINUE DEVELOPMENT OF TECHNIQUES FOR ESTIMATING THE RELIABILITY OF REDUNDANT DEVICES OF THIS TYPE. (4) INVESTIGATE THE APPLICATION OF THIS CLASS OF MACHINE AND THE TECHNIQUES USED IN ITS ORGANIZATION TO THE PROBLEMS OF AUTOMATIC MAINTENANCE AND CHECKOUT WITH SPECIAL EMPHASIS ON OBTAINING ADAPTIVE CAPABILITIES.

RTOP NO. 125-23-18 TITLE: SPACE SHUTTLE - ADVANCED SOFTWARE
TECHNIQUES FOR DATA MANAGEMENT SYSTEMS

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: MARLOWE, G. D. TEL. 713-483-6196

TECHNICAL SUMMARY

THE INTE-DEPENDENCE OF HARDWARE, SOFTWARE AND FUNCTIONAL APPLICATIONS MUST BE RECOGNIZED SINCE ANY ONE MAY INFLUENCE THE DESIGN OF THE OTHER DURING DEVELOPMENT PHASES. THE ONBOARD SOFTWARE SYSTEM MUST BE CONSIDERED IN THE EARLY STAGE OF DESIGN AND DEVELOPMENT OF THE SPACE SHUTTLE AVIONICS SYSTEM SO THAT THE IMPACT OF PROVIDING SOFTWARE FOR THE ONBOARD COMPUTER SYSTEMS WILL NOT BECOME A CONSTRAINT TO THE DESIGN AND DEVELOPMENT OF AN OPERATIONAL SPACE SHUTTLE. TO ASSURE PROPER EMPHASIS ON THE CRITICAL SOFTWARE/HARDWARE SYSTEM CONSIDERATIONS, THIS EFFORT WILL RESULT IN HARDWARE/SOFTWARE TRADEOFFS, PRELIMINARY SOFTWARE SYSTEM DESIGN, AND IDENTIFICATION OF HARDWARE/SOFTWARE TECHNIQUES TO ENHANCE SOFTWARE PREPARATION AND VERIFICATION.

RTOP NO. 125-23-19 TITLE: MULTIPLEX DATA BUS TECHNIQUES FOR THE
SPACE SHUTTLE

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

THE OBJECTIVE IS TO STUDY AND DEVELOP THE NECESSARY COMPONENT TECHNOLOGY AND SYSTEM TECHNIQUES WHICH WILL LEAD TO THE SELECTION AND DEMONSTRATION OF A MULTIPLEX DATA BUS SYSTEM APPROPRIATE FOR SPACE SHUTTLE APPLICATION. DIFFERENT TECHNIQUES WILL BE STUDIED WITH EMPHASIS ON THE ASSOCIATED HARDWARE REQUIREMENTS, RELIABILITY, DATA BANDWIDTHS, AND FLEXIBILITY OF APPLICATION.

RTOP NO. 125-23-20 TITLE: SYSTEM AND COMPONENT TECHNOLOGY RELATING
TO MASS DATA STORAGE FOR SPACE SHUTTLE

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE BOTH THE COMPONENT TECHNOLOGY AND ASSOCIATED SYSTEM DEVELOPMENT FOR THE BULK DATA STORAGE REQUIREMENTS OF THE SPACE SHUTTLE. THE SELECTION OF A SUITABLE STORAGE COMPONENT IS DEPENDENT UPON THOSE FACTORS AFFECTING DATA TRANSFER RATES, RELIABILITY AND THE PHYSICAL CONSTRAINTS OF SIZE, WEIGHT, AND POWER. A VARIETY OF TECHNIQUES ARE CURRENTLY IN EARLY PHASES OF DEVELOPMENT INCLUDING BOTH MOVING MEDIA AND SOLID STATE CONCEPTS. INITIAL EMPHASIS IS DIRECTED AT TRADE-OFF STUDIES TO SELECT THE MOST PROMISING TECHNOLOGY. WORK UNDER THIS RTOP TO BE COORDINATED WITH MASS MEMORY (TAPE RECORDER) STUDIES MSFC AND OTHER RELATED EFFORTS AT NASA CENTERS.

RTOP NO. 125-24-04 TITLE: ADVANCED AEROSPACE INSTRUMENTATION

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THIS RTOP COVERS THE TECHNOLOGY DEVELOPMENT OF IMAGING SYSTEMS WITH HIGH SPATIAL RESOLUTION AND EXTENDED SPECTRAL RANGE FOR POST-VIKING PLANETARY LANDINGS; THE ADAPTATION OF FLIGHT SPECTRORADIOMETRIC TECHNIQUES TO THE PROBLEM OF LOCATING AND QUANTIFYING SCHOOLING FISH AND TO THE DEVELOPMENT OF REMOTE SENSING TECHNIQUES FOR EARTH SURVEYS; THE DEVELOPMENT OF A FLUIDIC AIRSPEED SENSOR FOR V/STOL APPLICATIONS; THE DEVELOPMENT OF HIGH TEMPERATURE INSTRUMENTATION FOR MONITORING SPACE SHUTTLE STRUCTURAL AND HEAT PROTECTION MATERIAL CONDITIONS; THE DEVELOPMENT OF IMPROVED VACUUM AND ANALYTICAL INSTRUMENTATION ASSOCIATED WITH SPACE STATION OPERATIONS AND PLANETARY ATMOSPHERES; THE DEVELOPMENT OF LASER RADAR FOR DETERMINING ATMOSPHERIC CHARACTERISTICS FOR HIGH SPEED AIRCRAFT AND FOR MONITORING METEOROLOGICAL AND AIR POLLUTION CONDITIONS; AND FOR THE DEVELOPMENT OF NEW AND IMPROVED SOLID STATE SENSORS FOR APPLICATION IN REMOTE SENSORS FOR SPACE STATION, STRUCTURAL FATIGUE MONITORS FOR SPACE SHUTTLE AND HUMIDITY DETECTORS FOR PLANETARY MISSIONS.

RTOP NO. 125-24-07 TITLE: ADVANCED AEROSPACE MEASUREMENT METHODS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THIS RESEARCH COVERS THE DEVELOPMENT OF SEVERAL INSTRUMENTATION TECHNIQUES REQUIRED TO ADVANCE THE STATE OF THE ART OF MEASUREMENT TECHNOLOGY IN SUPPORT OF FUTURE NASA AEROSPACE RESEARCH MISSIONS. SPECIFIC PROBLEMS IN WHICH ADVANCEMENT OF TECHNOLOGY FOR AERONAUTICAL RESEARCH IS REQUIRED ARE; 1. THE DEVELOPMENT OF METHODS FOR MAKING FLOW PATTERNS VISIBLE IN LOW DENSITY GAS FLOWS CORRESPONDING TO THE HIGH ALTITUDE REGIMES OF SPACE SHUTTLE FLIGHTS. 2. THE DEVELOPMENT OF HIGHLY ACCURATE METHODS FOR MEASURING ALTITUDES IN THE RANGE 50,000 - 300,000 FT. 3. THE DEVELOPMENT OF A SYSTEM TECHNOLOGY FOR INTERCONNECTING ELECTRONIC EQUIPMENT IN AIRCRAFT BASED ON DIGITALLY ADDRESSABLE TRANSDUCER SYSTEMS IS NEEDED TO SIMPLIFY INSTALLATION AND OPERATION OF AIRBORNE DATA ACQUISITION SYSTEMS AND 4. THE DEVELOPMENT OF IMPROVED EFFICIENCY OPTICAL DETECTORS SUCH AS PHOTON MULTIPLIERS TO REDUCE EXPOSURE TIME OR APERTURE SIZE OF TELESCOPES IN COLLECTING SCIENTIFIC ASTRONOMICAL DATA ON SATELLITES OR FROM SPACE STATION EXPERIMENTS.

RTOP NO. 125-24-13 TITLE: ADVANCED IMAGING SYSTEMS TECHNOLOGY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THIS RTOP UNDERTAKES THE ASSESSMENT OF SPACE PLANETARY IMAGING SYSTEMS REQUIREMENTS, THE ASSESSMENT OF AVAILABLE AND PROJECTED TECHNOLOGY TO MEET THE REQUIREMENTS, AND THE IMPLEMENTATION OF SPECIFIC RESEARCH AND ADVANCED DEVELOPMENT TASKS TO PROVIDE THE ENABLING TECHNOLOGY FOR NASA. SEVERAL PROMISING TECHNIQUES HAVE BEEN PROPOSED FOR ADVANCING PLANETARY IMAGING TECHNOLOGY. THOSE TECHNIQUES WHICH OFFER POTENTIAL SOLUTIONS TO OUR CRITICAL PROBLEMS MUST BE DEVELOPED INTO A SYSTEM COMPATIBLE FORM AND EVALUATED IN A SYSTEM CONTEXT BEFORE THEY CAN BE CONSIDERED A CONTRIBUTION TO ENABLING TECHNOLOGY. AMONG THE TECHNIQUES TO BE INVESTIGATED ARE THOSE DERIVED FROM CONCEPTS OF SOLID STATE SENSOR MATRICES WITH ELECTRON BEAM READOUT, SOLID STATE SENSOR MATRICES WITH SELF SCANNING READOUT, DIELECTRIC TAPE STORAGE, AND EVEN SILVER HALIDE FILM SYSTEMS. THE NEED FOR DEVELOPMENT OF ENABLING TECHNOLOGY IN PLANETARY IMAGING IS MANIFESTED BY THE LACK OF SENSORS AND TECHNIQUES TO MEET THE OUTER PLANET IMAGING REQUIREMENTS FOR SENSITIVITY AND LONG LIFE. SPECIFICALLY, SENSITIVITY REQUIRED FOR IMAGING AT PLUTO IS NEARLY 1000 TIMES THAT REQUIRED AT MARS, AND MISSION TIMES OF UP TO 12 YEARS MUST BE PROVIDED FOR.

RTOP NO. 125-24-16 TITLE: AIRCRAFT FLIGHT TEST AND OPERATIONS
INSTRUMENTATION TECHNOLOGY

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: SANDERSON, K. C. TEL. 805-258-3311

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE TO DEVELOP PRECISION SENSORS AND SIGNAL CONDITIONING TO MEASURE RESEARCH PARAMETERS ON MANNED RESEARCH AIRCRAFT USED IN AERONAUTICAL RESEARCH. IN GENERAL, ANGLE OF SIDESLIP AND DYNAMIC PRESSURE AT ENTRY SPEEDS AND OVER LARGE ANGLES OF ATTACK, STAGNATION TEMPERATURE AT SUPERSONIC SPEEDS, HIGH TEMPERATURE STRAIN, ANGULAR ACCELERATION AND VELOCITY, LINEAR ACCELERATION, AND ADVANCED DIGITAL DATA ACQUISITION SYSTEMS FOR REAL TIME DATA COMPUTATIONS AND ANALYSIS AND IMPENDING FAILURE DETECTION ARE PROBLEMS OF INTEREST.

RTOP NO. 125-24-17 TITLE: ASTRONOMICAL INSTRUMENTATION FOR HIGH
PERFORMANCE AND DIFFRACTION

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: DUNKELMAN, L. TEL. 301-982-4988

TECHNICAL SUMMARY

DEVELOPMENT OF HIGH PERFORMANCE IMAGE RECORDING SYSTEM(S) WITH DETECTION CAPABILITY APPROACHING THE LIMIT SET BY PHOTON-NOISE STATISTICS. OTHER CHARACTERISTICS SUCH AS RESOLUTION, SPECTRAL RESPONSE, AND FORMAT ARE TO BE MATCHED TO SPACE TELESCOPE INSTRUMENTATION REQUIREMENTS WHICH ARE BEING DEVELOPED SIMULTANEOUSLY. THESE TECHNIQUES ARE TO BE USED TO ENHANCE THE SYSTEM PERFORMANCE OF THE SPACE TELESCOPES BY MEANS OF VARIABLE MAGNIFICATION AND REAL TIME IMAGE INFORMATION PROCESSING. SPECTRAL INFORMATION IS TO BE ISOLATED BY THE DEVELOPMENT AND APPLICATIONS OF DIFFRACTION GRATINGS PRODUCED BY HOLOGRAPHIC TECHNIQUES. STIGMATIC IMAGING, DISPERSION AND EFFECTIVE WORKING FOCAL RATIO ARE SOME OF THE CHARACTERISTICS WHICH MUST BE MATCHED TO THE DETECTION SYSTEM.

RTOP NO. 125-24-19 TITLE: SENSORS & INSTRUMENTATION FOR SPACE
SHUTTLE

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

THE SPACE SHUTTLE OPERATIONAL REQUIREMENTS ARE SUCH THAT TECHNOLOGY EXTENSION IS NEEDED IN THE AREAS OF PROPELLANT UTILIZATION SENSORS, ZERO "G" QUANTITY MEASUREMENTS AND AIR DATA SENSORS. THE EXTENSION OF TECHNOLOGY WILL BE ACCOMPLISHED BY RESEARCH FOR THESE AREAS BASED ON PAST EXPERIENCE OF ON-GOING RESEARCH IN THESE AREAS AND INSTRUMENTATION DEVELOPMENT ASSOCIATED WITH THE SATURN PROGRAM.

RTOP NO. 125-24-21 TITLE: STUDY OF A VEHICLE STATUS AND MONITORING
CONCEPT

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: LOVE, J. E. TEL. 805-258-3311

TECHNICAL SUMMARY

A STATE-OF-THE-ART SYSTEM DESIGNED FOR MONITORING AND CONTINUOUS IN-FLIGHT RECORDING OF PARAMETERS WHICH DETERMINE THE OPERATIONAL STATUS OF A VEHICLE WILL BE FLIGHT TESTED IN A HIGH PERFORMANCE JET AIRCRAFT. AFTER EACH FLIGHT, A QUICK ANALYSIS IS PERFORMED BY COMPUTER PROCESSING OF THE DIGITIZED MAGNETIC FLIGHT TAPE. OPERATIONAL DISCREPANCIES ARE DETECTED AND IDENTIFIED WHEN SENSED QUANTITIES EXCEED PREDETERMINED THRESHOLDS AS INSERTED INTO THE COMPUTER FOR ANALYSIS. THE TAPE ALSO SERVES AS A HISTORY OF OPERATION FROM WHICH PREDICTIONS OF MALFUNCTION OR FAILURE CAN BE MADE FROM LONG TERM (SEVERAL HUNDRED HOURS OF FLIGHT) PARAMETRIC TREND ANALYSIS. THE FLIGHT EXPERIENCE AND DATA ACCUMULATED WILL PROVIDE BASIC INFORMATION FOR SYSTEM REQUIREMENTS FOR THE SPACE SHUTTLE VEHICLE TO ACHIEVE SHORT TURNAROUND TIME BY AUTOMATIC SYSTEM TESTING, FAULT LOCATION, AND CHECKOUT.

RTOP NO. 125-25-05 TITLE: THICK FILM TECHNOLOGY - MATERIALS,
PROCESSING, AND TEST

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO INVESTIGATE MATERIALS, DEVICES, AND SYSTEMS FOR SPECIALIZED ELECTRONIC INSTRUMENTATION FOR AIRCRAFT, SPACECRAFT, AND OTHER RESEARCH VEHICLES. A SIGNIFICANT AMOUNT OF THIS WORK IS DIRECTED TO THE DEVELOPMENT OF INSTRUMENTATION WHICH MAY USE ONE-OF-A-KIND ELECTRONICS IN UNUSUAL ENVIRONMENTS WITH EMPHASIS ON SMALL SIZE AND WEIGHT, ACCURACY, STABILITY, AND POWER CONSUMPTION. MOST OF THE SPECIALIZED CIRCUIT DEVELOPMENT IS BASED ON THICK FILM TECHNOLOGY, WITH SUPPORTING R & D IN INTEGRATED CIRCUITS. A MAJOR OBJECTIVE WILL BE THE DEVELOPMENT OF REMOTE ATTACHMENT TELEMETRY TECHNIQUES FOR APPLICATION IN ADVANCED SPACECRAFT AND FOR IMPROVED INSTRUMENTATION ON RESEARCH AIRCRAFT. THE WORK ALSO INCLUDES TASKS IN LINE QUALIFICATION OF INTEGRATED CIRCUITS THROUGH STEP STRESS ANALYSIS.

RTOP NO. 125-25-06 TITLE: MATERIALS RESEARCH FOR ELECTRONIC DEVICES

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

NEW AND IMPROVED MATERIALS FOR ELECTRONIC DEVICES WILL BE DEVELOPED WHICH WILL PERFORM A RANGE OF FUNCTIONS SUCH AS THE EMISSION OF LIGHT FOR DISPLAY PURPOSES, THE CONTROL AND GENERATION OF MICROWAVE SIGNALS, AND THE STORAGE OF INFORMATION. IN ADDITION, TECHNIQUES FOR MODIFYING OR PRODUCING THESE MATERIALS WILL BE EMPLOYED WHICH PERMIT MORE FLEXIBILITY IN DEVICE CONSTRUCTION, FOR EXAMPLE, VAPOR GROWTH AND ION IMPLANTATION TECHNIQUES. FINALLY, NEW

MATERIALS WILL BE SOUGHT FOR FUTURE ELECTRONIC APPLICATIONS WHICH WILL WITHSTAND TEMPERATURE EXTREMES, HIGH-ENERGY RADIATION AND MECHANICAL SHOCK. IN-HOUSE AND CONTRACTUAL RESEARCH EFFORTS WILL BE PERFORMED TO DEVELOP MATERIALS FOR ELECTRONIC DEVICE APPLICATIONS. SPECIFICALLY, III-V SEMICONDUCTORS AND ALUMINUM ALLOY ELECTROLUMINESCENT MATERIALS WILL BE INVESTIGATED AS TO THE SPECTRAL RANGE AND INTENSITY OF THEIR EMITTED LIGHT FOR APPLICATION AS ELECTROLUMINESCENT LIGHT SOURCES. THE MAGNETIC PROPERTIES OF ORTHO-FERRITE MATERIALS WILL ALSO BE INVESTIGATED FOR POSSIBLE USE OF THE MATERIALS IN MICROWAVE PHASE SHIFTERS AND MEMORIES. ELEMENTAL AND COMPOUND SEMICONDUCTOR MATERIALS WILL BE DOPED WITH VARIOUS CHEMICAL IMPURITIES TO IMPROVE THEIR CHARACTERISTICS FOR APPLICATION TO MICROWAVE SOURCES.

RTOP NO. 125-25-07 TITLE: ELECTRONIC COMPONENTS FOR SPACE
STATION/BASE

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THE BASIC OBJECTIVE OF THIS EFFORT IS TO DEVELOP NEW AND IMPROVED ELECTRONIC COMPONENTS WHICH EXHIBIT LONGER LIFETIME, TOLERANCE TO ENVIRONMENTAL EXTREMES, INCREASED VERSATILITY, LOWER POWER DRAIN, AND REDUCED SIZE AND WEIGHT FOR APPLICATION IN THE ELECTRONIC SYSTEMS OF THE SPACE STATION. IMMEDIATE GOALS ARE (1) THE DEVELOPMENT OF METAL-NITRIDE-OXIDE-SEMICONDUCTOR (MNOS) DEVICE TECHNOLOGY FOR APPLICATION IN COMPUTER MEMORY SYSTEMS, (2) THE DEVELOPMENT OF ELECTROLUMINESCENT SOLID STATE AND LIQUID CRYSTAL DEVICES FOR APPLICATION IN DISPLAY SYSTEMS, AND (3) THE DEVELOPMENT OF SOLID STATE MICROWAVE DEVICES FOR APPLICATION IN THE COMMUNICATION SYSTEMS. OBJECTIVES WILL BE PURSUED UNTIL EFFECTIVE PERFORMANCE CAPABILITY HAS BEEN DEMONSTRATED BY BREADBOARD OR PROTOTYPE MODELS AND DEVICE PERFORMANCE PARAMETERS HAVE BEEN CHARACTERIZED. IN-HOUSE AND CONTRACT EFFORTS WILL INCLUDE THE DEFINITION OF SPECIFIC COMPONENT PROBLEMS TO BE ENCOUNTERED IN THE DESIGN AND OPERATION OF THE SPACE STATION AND INITIATION OR CONTINUATION OF R AND D ACTIVITIES TO SOLVE THOSE PROBLEMS ON A TIMELY BASIS. ON-GOING CONTRACTUAL ACTIVITIES INITIATED AT ELECTRONICS RESEARCH CENTER IN THE AREAS OF MNOS MEMORY DEVICES, DISPLAY DEVICES, AND MICROWAVE SOURCES WILL BE CONTINUED. IN-HOUSE EFFORTS WILL INCLUDE THE EVALUATION OF EXPERIMENTAL AND PROTOTYPE DEVICES.

RTOP NO. 125-25-08 TITLE: DESIGN, PROCESSING AND TESTING OF LSI
ARRAYS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

OBJECTIVES: THE OVERALL OBJECTIVE OF THIS EFFORT IS DIRECTED TOWARD DEVELOPING THE TECHNOLOGY AND TECHNIQUES FOR THE DESIGN, FABRICATION AND TESTING OF LARGE SCALE INTEGRATED CIRCUIT ARRAYS. THIS ENCOMPASSES THE DESIGN, DEVELOPMENT AND IMPLEMENTATION OF

AUTOMATIC TEST EQUIPMENT INCLUDING COMPUTER SOFTWARE TO PERFORM DYNAMIC AS WELL AS FUNCTIONAL TESTS ON LSI ARRAYS. PROCESS TECHNOLOGY DEVELOPMENT WILL BE PURSUED IN THE PROMISING AREAS WHERE NEED EXISTS. FOR INSTANCE, THE APPLICATION OF BEAM LEADS TO MOS DEVICES IS AN IMMEDIATE SOLUTION TO THE PASSIVATION AND INTERCONNECTION PROBLEM. INHERENT IN THESE BROAD OBJECTIVES IS THE MAXIMUM USE OF AN IN-HOUSE COMPUTER FACILITY. SPECIAL EMPHASIS WILL BE GIVEN TO INTERACTIVE GRAPHICS.

RTOP NO. 125-25-11 TITLE: ELECTRONIC COMPONENT PACKAGING AND INTERCONNECTION R & D

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

EXPLORATION OF THE OUTER PLANETS WILL REQUIRE HIGH RELIABILITY SPACECRAFT WITH AT LEAST A FOUR TO ONE INCREASE IN ELECTRONIC COMPONENT DENSITY FOR EXTENDED MISSION FLIGHT TIMES. THE FUNCTION OF ELECTRONIC PACKAGING AND CABLING IS THE MECHANICS OF TRANSLATING ELECTRONIC SCHEMATICS AND COMPONENTS INTO EQUIPMENT CAPABLE OF PERFORMING ITS ELECTRICAL DESIGN FUNCTION. IT IS THE APPLICATION OF ENGINEERING METHODS AND TECHNIQUES TO MECHANICAL DESIGN, FABRICATION, INTERCONNECTION, AND INTEGRATION TO ASSURE OPERATION OF ELECTRONIC EQUIPMENT IN SPECIFIED ENVIRONMENTS. THIS PERFORMANCE MUST BE PREDICTABLE AND NOT DEGRADED BY ENVIRONMENTAL STRESSES IMPOSED BY FABRICATION, INSPECTION, TEST, REPAIR, GROUND ATMOSPHERE, LAUNCH, AND SPACE. SPECIFIC PROGRAMS IN THE FIELDS OF ELECTRONIC INTERCONNECTIONS, MICROELECTRONIC PACKAGING, HYBRID THICK FILMS AND HIGH VOLTAGE TECHNOLOGY CAN PROVIDE SOLUTIONS TO THE CRITICAL PROBLEMS. EACH OF THE OBJECTIVES IN THE TECHNICAL PLAN FALL WITHIN ONE OF THESE FOUR FIELDS. REQUIREMENTS INDICATE A NEED FOR HIGH DENSITY CONNECTORS AND CABLING. AVAILABLE FLAT CABLES AND ASSOCIATED HIGH DENSITY CONNECTORS AND HARDWARE CAN BE USED TO HELP MEET THE INCREASED REQUIREMENTS. ANOTHER WAY TO ACHIEVE GREATER COMPONENT DENSITY IS TO USE THICK FILMS TO COMBINE RESISTORS, CAPACITORS, MICROELECTRONIC PARTS, MSI'S, LSI'S, AND INTEGRATED CIRCUITS INTO HYBRID PACKAGING. THE JOINING OF THE PARTS TO THE THICK FILMS WOULD BE MADE BY VARIOUS BONDING METHODS SUCH AS THERMO-COMPRESSION BONDING, REFLOW SOLDERING AND ULTRASONIC BONDING. A COMPUTER-AIDED PROGRAM WILL BE SOUGHT TO GENERATE THE HYBRID THICK FILM CIRCUIT ARTWORK. HIGH VOLTAGE TECHNOLOGY AND DESIGN AND TEST CAPABILITIES WILL PROGRESS AS A RESULT OF EVALUATING A 12KV, FY'70 FABRICATED, CORONA FREE TRANSFORMER AND BY USING THE DATA AS AN AID TO AN ULTIMATE 100KV DESIGN CAPABILITY.

RTOP NO. 125-25-12 TITLE: ELECTRONIC COMPONENT SCREENING AND QUALIFICATION DEVELOPMENT

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

THE SPACECRAFT MISSIONS BEING CONSIDERED FOR THE 1970'S AND

BEYOND DIFFER FROM THEIR PREDECESSORS IN THAT 1) MISSION TIME WILL BE SIGNIFICANTLY LONGER, 2) THE ENVIRONMENT WILL BE MORE SEVERE AND 3) THE SPACECRAFT WILL BE MORE COMPLEX. THE GRAND TOUR, FOR EXAMPLE, WILL REQUIRE A FLIGHT TIME OF 10 YEARS IN A RADIATION ENVIRONMENT. THIS IS AN ORDER OF MAGNITUDE MORE DEMANDING THAN ANY MISSION PREVIOUSLY ATTEMPTED. EVEN A CURSORY REVIEW OF THE LONGEVITY RECORD OF PREVIOUS SPACECRAFT REVEALS THAT THE RELIABILITY DEMONSTRATED BY THEIR ELECTRONICS IS TOTALLY INADEQUATE FOR MISSIONS OF 10 YEARS DURATION. WHEN CONSIDERATION OF THE ENVIRONMENTAL AND COMPLEXITY FACTORS OF FUTURE SPACECRAFT ARE INTRODUCED, THE DISPARITY BETWEEN THE DEGREE OF RELIABILITY ACHIEVED IN THE PAST AND THAT WHICH IS REQUIRED IN THE FUTURE BECOMES EVEN GREATER. THE PROBLEM OF HOW TO ACHIEVE EXCEPTIONALLY LONG LIFE IN ELECTRONIC DEVICES FOR USE IN FUTURE SPACECRAFT IS DEFINITELY REAL AND MISSIONS OF 10 YEARS DURATION WILL HAVE A REASONABLE PROBABILITY OF SUCCESS ONLY WHEN THE PROBLEM IS SOLVED. THE EFFORT PROPOSED IN THIS TASK IS THE RESEARCH AND THE METHODOLOGY DEVELOPMENT NECESSARY TO PREPARE THE WAY FOR ACTUAL DEVELOPMENT AND SELECTION OF HIGHLY RELIABLE LONG-LIFE ELECTRONIC DEVICES REQUIRED BY FUTURE SPACECRAFT. PARTICULAR ATTENTION IS FOCUSED ON THE PROBLEM OF ACHIEVING LONG-LIFE MSI/LSI DEVICES. THE LONG RANGE APPROACH IS TO IDENTIFY FAILURE MECHANISMS WHICH LIMIT THE LONG-LIFE RELIABILITY OF ELECTRONIC DEVICES AND RELATE THESE MECHANISMS TO SPECIFIC ELEMENTS IN THE DEVICE DESIGN OR PROCESSING. THE OVER-ALL TASK WILL BE PURSUED THROUGH A COMBINATION OF BOTH IN-HOUSE AND CONTRACTED EFFORTS.

RTOP NO. 125-25-18 TITLE: SCREENING AND RELIABILITY TESTING FOR
SPACE SHUTTLE

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

TO DEVELOP EFFECTIVE PROCEDURES FOR ECONOMICAL QUALIFICATION AND RELIABILITY ASSURANCE OF LARGE SCALE INTEGRATED CIRCUITS (LSI) AND OTHER MICROELECTRONIC DEVICES THAT ARE SELECTED FOR USE IN SPACE SHUTTLE SYSTEMS. THIS WILL ENCOMPASS STUDYING AND UNDERSTANDING THE DESIGN, FAILURE MECHANISMS, CRITICAL PROCESSES, WORKMANSHIP AND APPLICATION CAPABILITY OF LSI DEVICES SO EFFECTIVE PROCEDURES AND CRITERIA CAN BE ESTABLISHED FOR SCREENING, INSPECTION AND TESTING. ALL ASPECTS OF LSI CIRCUIT DESIGN AND MANUFACTURE; FROM BASIC SILICON MATERIAL THROUGH JUNCTIONS, METALLIZATION, INTERCONNECTION, PACKAGING AND APPLICATION, MUST BE CONSIDERED TO ASSURE ACCEPTABLE END ITEM RELIABILITY. THESE ACTIVITIES WILL BE DIRECTED IN A MANNER TO PROVIDE RELIABILITY ASSURANCE FOR THE WIDEST SELECTION OF DEVICES NECESSARY FOR THE DESIGN ENGINEERS TO DEVELOP THE MOST ADVANCED MICROELECTRONICS SYSTEMS. THE FIRST APPROACH WILL ASSURE COVERAGE FOR BEAM LEADED MOS AND BIPOLAR CHIPS BEING DEVELOPED AND PACKAGED WITH HYBRID TECHNIQUES, BOTH OF WHICH ARE COVERED UNDER RTOPS 125-25-08 (FY 71) AND 125-64-21 (FY 70). BACK UP APPROACHES WILL PROVIDE COVERAGE FOR DEVICES OF LESSER INTEGRATION USING FLYING LEADS AND CONVENTIONAL PACKAGING.

RTOP NO. 125-25-19 TITLE: MANNED SPACE SHUTTLE: MATERIALS FOR
ANTENNA PROTECTIVE COATINGS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

RESEARCH WILL BE PERFORMED TO IDENTIFY AND, WHERE NECESSARY, DEVELOP DURABLE DIELECTRIC MATERIALS SUITABLE AS RADOMES OR FLUSH MOUNTED ANTENNA ARRAY COVERS FOR SPACE SHUTTLE VEHICLES. INVESTIGATIONS ARE CONCENTRATED ON MATERIALS EXHIBITING MECHANICAL INTEGRITY, HIGH DIELECTRIC STRENGTH AND LOW DIELECTRIC LOSSES AT HIGH TEMPERATURES AND MICROWAVE FREQUENCIES AND WHICH ARE AMENABLE TO PREPARATION IN THE REQUIRED CONFIGURATIONS. DURING FY '71 A COOPERATIVE PROGRAM WITH DOD WILL BE CONDUCTED ON CONTRACT TO DETERMINE THE APPLICABILITY OF EXISTING RADOME MATERIALS AS HIGH TEMPERATURE ANTENNA COVERS. THE MOST PROMISING MATERIALS IDENTIFIED WILL BE TESTED AND EVALUATED AT LANGLEY RESEARCH CENTER UNDER HIGH DYNAMIC HEATING ENVIRONMENTS. SPACE SHUTTLE PHASE B CONTRACTOR STUDIES WILL BE REVIEWED TO DETERMINE THE REQUIREMENTS OF SPECIAL MATERIALS FOR PROPOSED ANTENNA SYSTEMS. DURING FY '72 RADOME AND OTHER ANTENNA MATERIALS WILL BE IDENTIFIED FOR APPLICATION ON SPACE SHUTTLE VEHICLES. ALSO, THE MATERIAL REQUIREMENTS FOR LARGE ARRAYS WILL BE INVESTIGATED AND TECHNOLOGY DEVELOPED WHERE FEASIBLE. DURING FY '73 PROTOTYPE ANTENNA COVERINGS WILL BE FABRICATED AND EVALUATED FOR CRITICAL DESIGN AREAS ON THE SPACE SHUTTLE VEHICLE.

RTOP NO. 125-25-20 TITLE: EXTREME TEMPERATURE AND LIFE TEST
REQUIREMENTS FOR ELECTRONICS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DETERMINE EXTREME TEMPERATURE REQUIREMENTS (ETR) FOR ELECTRONIC COMPONENT DEVELOPMENT WITHIN THE SCOPE OF FUTURE NASA MISSIONS & TO DETERMINE QUALIFICATION STANDARDS AND VERIFICATION TECHNIQUES FOR ACCELERATED LIFE TESTS OF ELECTRONIC ASSEMBLIES USED ON FUTURE LONG LIFE NASA SPACECRAFT. AN ADDITIONAL OBJECTIVE IS TO ADVANCE THE SOLID-STATE TRIODE (SST) DISCOVERED UNDER NASA WORK UNIT 129-29-02-05-09 FROM THE FEASIBILITY STAGE TO A QUALIFIED COMPONENT THAT CAN BE USED AS A DRIVER FOR SWITCHING HIGH VOLTAGES AND/OR HIGH CURRENTS FOR CHARGE-STORAGE FET AND/OR CORE MEMORIES, AND THAT CAN BE USED WHERE HIGH TEMPERATURES MAY BE ENCOUNTERED. THE ETR APPROACH IS TO EXAMINE THE CAPABILITY OF THERMAL CONTROL TECHNIQUES TO MAINTAIN ACCEPTABLE TEMPERATURES WITH REASONABLE WEIGHT AND POWER FOR THE VARIOUS SPACECRAFT MISSIONS. THOSE ITEMS (SUCH AS SENSORS) WHICH MAY NOT BE MAINTAINED AT ACCEPTABLE TEMPERATURES WILL BE IDENTIFIED AND ALTERNATIVE APPROACHES FOR THE PROBLEM SOLUTIONS EXAMINED. THIS WILL EITHER RESULT IN A PROBLEM FIX OR DEVELOPMENTAL GUIDELINES. THE APPROACH TO THE ACCELERATED LIFE TEST REQUIREMENTS TASK WILL BE TO EXPAND UPON THE ETR STUDY OF MISSIONS TO THE OUTER PLANETS. INITIAL ACTIVITIES WILL INCLUDE THE FORMULATION OF A MODEL WHICH DEFINES THE LONG LIFE MISSION, ELECTRONICS PARTS TYPES, AND TEMPERATURE HISTORY FOR THE MISSION. IT IS ANTICIPATED THAT THIS EFFORT WILL BE BASED ON THE

OUTER PLANET MISSION STUDY AND ETR REPORT (JPL 701-29). ONCE THE MODEL IS FORMULATED A STATISTICAL EVALUATION OF FAILURE RATE DATA AVAILABLE FOR INDIVIDUAL ELECTRONICS PIECE PARTS FOUND IN THE ASSEMBLIES WILL BE PERFORMED. THE RELIABILITY DATA WILL BE USED TO DETERMINE APPROPRIATE ACCELERATED LIFE TEST FACTORS FOR PIECE PARTS (PERHAPS AS A GROUP OF TYPES). AS A PART OF THIS ACTIVITY THE REQUIREMENTS FOR FAILURE RATE DATA WHICH NEEDS TO BE SUPPLIED AND THE METHODS OF TREATMENT TO BE EMPLOYED ONCE IT BECOMES AVAILABLE WILL BE IDENTIFIED.

RTOP NO. 126-13-10 TITLE: GENERAL AERODYNAMICS
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: SALTZMAN, E. J. TEL. 805-258-3311
TECHNICAL SUMMARY

VARIOUS FLIGHT VEHICLES WILL BE USED TO INVESTIGATE LOCAL AERODYNAMICS THAT ARE ESSENTIALLY INDEPENDENT OF THE AIRCRAFT CONFIGURATION BUT ARE DEPENDENT ON ENVIRONMENTS AND REYNOLDS NUMBERS ACHIEVEABLE THROUGH THE USE OF THE AIRCRAFT AND CANNOT BE ADEQUATELY REPRODUCED IN GROUND FACILITIES. AREAS OF INVESTIGATION WILL INCLUDE SKIN FRICTION, BASE DRAG, ROUGHNESS EFFECTS, AND AN ASSESSMENT OF BOUNDARY LAYER PARAMETERS AS AFFECTED BY PRESSURE GRADIENT. WHERE HIGH REYNOLDS NUMBERS ARE REQUIRED, THE WORK WILL BE DONE ON LARGE AIRCRAFT SUCH AS THE C-141 OR ON HIGH SPEED AIRCRAFT SUCH AS THE YF-12 AND THE SST PROTOTYPE. WHERE THIS CONDITION IS NOT CRITICAL THE WORK MAY BE DONE ON A SPECIAL FIN ATTACHED TO AN F-104 OR BY MEANS OF A FREE FALL DROP BODY IF IT IS DESIRABLE TO ELIMINATE THE EFFECT OF ADJACENT BODIES.

RTOP NO. 126-13-10 TITLE: GENERAL AERODYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THIS RESEARCH DEALS WITH THEORETICAL AND EXPERIMENTAL AERODYNAMIC INVESTIGATIONS OF COMPONENTS, COMBINATIONS, AND COMPLETE RESEARCH CONFIGURATIONS FOR AERONAUTICAL VEHICLES THROUGHOUT THE FLIGHT SPEED RANGE. IT INCLUDES CONTINUING STUDIES OF FLOW FIELDS AND BOUNDARY LAYER PHENOMENA, HEAT TRANSFER, VORTEX AND INTERFERENCE FLOWS, COMPUTER PREDICTION METHODS AND CORRELATION WITH EXPERIMENT, AERODYNAMICS OF FLEXIBLE WINGS (PARAWINGS) FOR AERONAUTICAL APPLICATIONS, EXTERNAL STORE EFFECTS AND SEPARATION CHARACTERISTICS, AND EXPERIMENTALLY DETERMINED DYNAMIC DERIVATIVES. ALSO RESEARCH ON MIXED TRANSONIC FLOWS, HIGH REYNOLDS NUMBER EFFECTS, FLOW SEPARATION AND SUPERSONIC WING DESIGN. THIS RESEARCH IS BEING ACCOMPLISHED BY THE DEVELOPMENT OF NEW THEORETICAL APPROACHES, THE APPLICATION OF EXISTING THEORIES AND BY SYSTEMATIC WIND-TUNNEL AND FLIGHT TESTING. THE PURPOSE IS TO PROVIDE ADVANCED RESEARCH INFORMATION AND TECHNIQUES FOR PREDICTING AND IMPROVING THE AERODYNAMICS OF

AERONAUTICAL VEHICLES.

RTOP NO. 126-13-11 TITLE: SONIC BOOM GENERATION AND PROPAGATION
ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP AN IMPROVED UNDERSTANDING OF SONIC BOOM PHENOMENA, TO PROVIDE MORE ACCURATE AND MORE CONVENIENT PREDICTION TECHNIQUES, AND TO DEVELOP DESIGN METHODS THAT WILL LEAD TO ADVANCED LOW-BOOM SST AND HST CONFIGURATIONS WHICH RETAIN ATTRACTIVE ECONOMIC FEATURES. ALTHOUGH THE PRIMARY EMPHASIS CONTINUES TO BE DIRECTED TO STEADY LEVEL FLIGHT, INCREASING ATTENTION WILL BE DEVOTED TO A STUDY OF ATMOSPHERIC AND TOPOGRAPHICAL FOCUSING, THE EFFECTS OF ATMOSPHERIC TURBULENCE, AND THE INFLUENCE OF AIRCRAFT ACCELERATION AND MANEUVERS. THE RESEARCH WILL BE ACCOMPLISHED BY WIND-TUNNEL AND LABORATORY EXPERIMENTATION, BY THE CONDUCT OF THEORETICAL STUDIES, AND BY THE ACQUISITION AND ANALYSIS OF DATA FROM FLIGHT TEST PROGRAMS.

RTOP NO. 126-14-10 TITLE: (U) GUST LOADS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THE WORK TO BE PERFORMED UNDER THIS RTOP IS TO PROVIDE THE TECHNOLOGY DEVELOPMENT NECESSARY FOR IMPROVED ABILITY TO HANDLE GUST LOADS AND RESPONSE IN THE DESIGN OF NEW AIRCRAFT. THIS WORK WILL PROVIDE A BETTER UNDERSTANDING OF THE EFFECTS OF COMBINED VERTICAL AND LATERAL INPUTS FOR A MORE RATIONAL PREDICTION OF GUST LOADS IN THE REAL ENVIRONMENT. RESPONSE CALCULATION METHODS WILL BE VALIDATED BY CORRELATION WITH EXISTING FLIGHT DATA AND WITH EXPERIMENTAL RESULTS TO BE OBTAINED IN USING AN AIRSTREAM OSCILLATOR. EXPERIMENTAL AND ANALYTICAL STUDIES OF METHODS OF ALLEVIATING RESPONSE THROUGH MODAL SUPPRESSION SYSTEMS WILL BE MADE. ISOLATION SYSTEMS WILL BE MADE.

RTOP NO. 126-14-11 TITLE: AERODYNAMIC LOADS INCLUDING ACOUSTIC
RESPONSE

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBINSON, R. G. TEL. 415-961-2280

TECHNICAL SUMMARY

FOR AN AIRCRAFT DESIGNER TO DESIGN RELIABLE STRUCTURES OF MINIMUM WEIGHT HE MUST BE ABLE TO PREDICT ACCURATELY THE AERODYNAMIC LOADS OVER THE AIRCRAFT FOR THE EXPECTED FLIGHT CONDITIONS. THERE IS CONSIDERABLE NEED FOR RESEARCH IN THE PREDICTION OF LOADS AND ACOUSTIC RESPONSE OF STRUCTURES AT SPEEDS RANGING FROM TRANSONIC TO HYPERSONIC AND AT REYNOLDS NUMBERS APPROACHING FLIGHT CONDITIONS. EXPERIMENTAL STUDIES OF MODELS IN WIND TUNNELS ARE IN PROGRESS TO AID IN THE DEVELOPMENT OF METHODS FOR PREDICTING THESE EFFECTS FOR HIGH

PERFORMANCE AIRCRAFT.

RTOP NO. 126-14-12 TITLE: (U) BUFFETING
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

ADVANCED FIGHTER AIRCRAFT MUST HAVE IMPROVED MANEUVERABILITY. IN SOME CASES, MANEUVERABILITY CAN BE LIMITED BY THE OCCURRENCE OF BUFFETING. THIS RESEARCH IS INTENDED TO PROVIDE INFORMATION ON THOSE CONFIGURATION CHARACTERISTICS WHICH WOULD IMPROVE BUFFET BOUNDARIES AND TO DEVELOP TECHNIQUES FOR PREDICTING BUFFETING INTENSITY BEYOND THE BOUNDARY. RESULTS OF THIS WORK SHOULD BE DIRECTLY APPLICABLE IN THE DEVELOPMENT OF THE F-14 AND F-15 FIGHTER AIRCRAFT. SINCE BUFFETING IS ASSOCIATED WITH SEPARATED FLOW, THE WORK WILL BE PRIMARILY EXPERIMENTAL IN NATURE. WIND-TUNNEL TECHNIQUES FOR PREDICTING BUFFET BOUNDARY AND BUFFET INTENSITY WILL BE VALIDATED BY COMPARISON WITH FLIGHT RESULTS.

RTOP NO. 126-14-12 TITLE: AERODYNAMIC BUFFET
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-1111
TECHNICAL SUMMARY

THE PERFORMANCE, MANEUVERABILITY, AND SOMETIMES THE SAFETY OF AIR VEHICLES IS FREQUENTLY LIMITED OR JEOPARDIZED BY THE APPEARANCE, UNDER CERTAIN FLIGHT CONDITIONS, OF THE LARGE, UNSTEADY AERODYNAMIC FORCES KNOWN AS BUFFET. SOME OF THE PROBLEMS RESULTING FROM BUFFET ARE PILOT ANNOYANCE, REDUCED PRECISION OF AIRCRAFT CONTROL, INABILITY TO ACCOMPLISH SOME MANEUVERS THAT ARE POSSIBLE UNDER NON-BUFFET CONDITIONS, AND POSSIBLE STRUCTURAL FAILURE. A RELATIVELY LARGE WIND TUNNEL MODEL, CORRESPONDING TO AN AIRCRAFT FOR WHICH CONSIDERABLE FLIGHT DATA IN BUFFET CONDITIONS EXIST, IS BEING FABRICATED. MEASUREMENTS WILL BE TAKEN OF ALL FACTORS REASONABLY EXPECTED TO CAUSE OR INFLUENCE BUFFET, AND OF THE ACTUAL AERODYNAMIC MECHANISM OF THE BUFFET PROCESS. AN EFFORT WILL BE MADE TO DESCRIBE THE PROCESS ANALYTICALLY IN ORDER TO PROVIDE A MORE FUNDAMENTAL UNDERSTANDING AND ALLOW FOR BUFFET PREDICTION.

RTOP NO. 126-14-13 TITLE: (U) ACOUSTIC RESPONSE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THIS WORK INCLUDES THE RESPONSE OF FLIGHT STRUCTURES TO ACOUSTIC LOADS, SUCH AS THOSE FROM THE AERO BOUNDARY LAYER AND THE POWER PLANTS. INCLUDED ARE SUCH SPECIFIC TOPICS AS SONIC FATIGUE, NOISE TRANSMISSION, VIBRATION RESPONSES OF COMPLEX STRUCTURES SUCH AS PAYLOADS, AND THE DEFINITION OF BOUNDARY LAYER LOADS ON AERO SURFACES. BOTH ANALYTICAL AND EXPERIMENTAL STUDIES ARE INVOLVED. WIND-TUNNEL, FREE-FLIGHT, AND GROUND SIMULATION TESTS OVER A

TEMPERATURE RANGE ARE ANTICIPATED. THE OBJECTIVES OF THE WORK ARE TO BE ABLE TO PREDICT THE RESPONSES OF VARIOUS TYPES OF STRUCTURES TO ACOUSTIC LOADS, AND TO BE ABLE TO DESIGN LIGHTER WEIGHT NOISE RESISTANT STRUCTURES.

RTOP NO. 126-14-14 TITLE: (U) FLUTTER AND AEROELASTICITY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE RESEARCH EFFORT TO BE CONDUCTED UNDER THIS RTOP IS INTENDED TO PROVIDE THE TECHNOLOGY FOR THE ACCURATE PREDICTION OF FLUTTER AND OTHER AEROELASTIC PHENOMENA. THE METHODS WILL BE BOTH EXPERIMENTAL AND ANALYTICAL IN NATURE AND EMPHASIS WILL BE PLACED ON MAKING THE METHODS SUITABLE FOR USE DURING AIRCRAFT DESIGN. IMPROVEMENTS IN THE ACCURACY OF THESE PREDICTION AND DESIGN METHODS WILL PROVIDE FOR SAFER, MORE EFFICIENT AIRCRAFT DESIGNS. THE WORK WILL INCLUDE THE FOLLOWING: 1. IMPROVED REPRESENTATIONS OF UNSTEADY AERODYNAMICS, INCLUDING VALIDATION OF THESE METHODS BY COMPARISON WITH WIND-TUNNEL EXPERIMENTS. 2. FURTHER DEVELOPMENT OF THE THEORY AND PRACTICAL METHODS OF OPTIMIZING DESIGNS FOR AEROELASTIC RESTRAINTS. 3. CONTINUE DEVELOPMENT AND APPLICATION OF ANALYTICAL AND EXPERIMENTAL TECHNIQUES FOR THE STUDY OF AERELASTIC PROBLEMS. 4. EXPLORATORY STUDIES OF AEROELASTIC PROBLEMS ASSOCIATED WITH HYPERSONIC FLIGHT. THE WORK WILL INCLUDE BOTH IN-HOUSE, UNIVERSITY GRANT, AND CONTRACTUAL EFFORTS.

RTOP NO. 126-14-14 TITLE: PANEL FLUTTER AND AEROELASTICITY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-1111
TECHNICAL SUMMARY

THE NECESSITY FOR UTILIZING LIGHT WEIGHT STRUCTURAL MATERIALS AND TECHNIQUES IN AIRCRAFT CONSTRUCTION INTRODUCES THE PROBLEMS OF PANEL FLUTTER AND AEROELASTICITY. IN THE CASE OF PANEL FLUTTER, EXCESSIVE HEATING OF THE EXTERNAL SURFACE DICTATES, IN MANY CASES, THE USE OF AN OUTER COVERING CONSISTING OF SEMI-INDEPENDENT PANELS WHICH ARE RELATIVELY FREE TO EXPAND AND CONTRACT. BECAUSE OF THE MATERIALS OF CONSTRUCTION AND THE LIGHT WEIGHT OF THESE PANELS, THEY ARE SUSCEPTIBLE TO FLUTTER. CONSIDERABLE NEW RESEARCH INFORMATION IS NEEDED ON THE CHARACTERISTICS OF SUCH PANELS WHEN EXPOSED TO CONDITIONS NOT ENCOUNTERED IN THE PAST. AEROELASTICITY OF STRUCTURES IS AN OLDER SUBJECT, HOWEVER, THE ADVENT OF LONGER, SLENDER AERONAUTICAL VEHICLES, AND INCREASED AIRCRAFT SPEEDS, INTRODUCES THE NEED FOR NEW APPROACHES TO PREDICTING EFFECTS OF AEROELASTICITY ON STABILITY DERIVATIVES.

RTOP NO. 126-14-15 TITLE: FATIGUE OF AIRCRAFT STRUCTURAL MATERIALS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE DELETERIOUS ENVIRONMENTAL EFFECTS ON FATIGUE PROPERTIES OF AIRCRAFT STRUCTURAL METALS ARE BEING STUDIED IN ORDER TO DEVELOP TECHNIQUES FOR PREDICTING AND FOR MINIMIZING SUCH EFFECTS. THE METALS WILL INCLUDE ALUMINUM, NICKEL, IRON, AND TITANIUM ALLOYS, AND THE ENVIRONMENTS WILL INCLUDE DRY AIR, HUMID AIR WITH AND WITHOUT SALT, AND HYDROGEN, OVER A RANGE OF TEMPERATURES. MANY OF THE FAILURES WHICH HAVE OCCURRED IN CURRENT HIGH-PERFORMANCE AIRCRAFT HAVE BEEN UNDER CONDITIONS OF CYCLIC LOADING IN UNFAVORABLE ENVIRONMENTS. AS DEMANDS INCREASE FOR MATERIALS TO FUNCTION AT THE LIMITS OF THEIR CAPABILITY IN SUCH ENVIRONMENTS, THERE IS URGENT NEED FOR TECHNIQUES TO PREDICT THE EFFECTS OF THE ENVIRONMENT ON MATERIAL PERFORMANCE TO AID THE PROPER SELECTION OF MATERIALS AND PROTECTIVE METHODS.

RTOP NO. 126-14-15 TITLE: FATIGUE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO INCREASE THE RELIABILITY AND SAFETY OF CONTEMPORARY AND FUTURE AIRCRAFT BY DEVELOPING THE UNDERSTANDING OF THE FATIGUE PHENOMENA AND BY GENERATING ENGINEERING RULES USEFUL IN AIRCRAFT DESIGN AND FATIGUE ANALYSES. FATIGUE DAMAGE JEOPARDIZES THE INTEGRITY OF AIRCRAFT IN A LARGELY UNPREDICTABLE MANNER, THUS IMPERILING PASSENGERS OR MILITARY MISSIONS. FACTORS AFFECTING FATIGUE PERFORMANCE ARE NUMEROUS AND INCLUDE THE MAGNITUDE, SEQUENCE, AND STATISTICAL CONTENT OF LOADS, GEOMETRY OF A PART, CORROSION, TYPE OF AIRCRAFT MISSION, AND MATERIAL OF CONSTRUCTION. FUTURE HIGH SPEED AIRCRAFT WILL ADDITIONALLY BE SUBJECTED TO ELEVATED TEMPERATURES AND WILL UTILIZE MANY NEW MATERIALS INCLUDING SUPERALLOYS AND COMPOSITES. THE EFFECTS OF SUCH FACTORS ON FATIGUE BEHAVIOR WILL BE INVESTIGATED IN THE FOLLOWING AREAS: 1. FUNDAMENTAL MECHANISMS OF FATIGUE 2. CRACK PROPAGATION AND RESIDUAL STRENGTH 3. FATIGUE OF COMPOSITE MATERIALS 4. DESIGN PROCEDURES FOR LONG FATIGUE LIFE 5. STRUCTURAL FATIGUE UNDER STOCHASTIC LOADING. THE RESULT OF THIS RESEARCH WILL HELP DESIGNERS IMPROVE THE RESISTANCE OF STRUCTURES TO FATIGUE AND IMPROVE ANALYSIS OF FATIGUE PROBLEMS; THE RESULTS WILL HELP OPERATORS MAINTAIN SAFETY AND PROLONG THE USEFUL LIFE OF AIRCRAFT. TO ACCOMPLISH THE OBJECTIVE, FATIGUE ANALYSIS METHODS WILL BE DEVELOPED; EXPERIMENTS WILL BE CONDUCTED TO VERIFY ANALYSES.

RTOP NO. 126-14-16 TITLE: STRUCTURAL MECHANICS AND COMPUTER METHODS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K. TEL. 703-827-3285
TECHNICAL SUMMARY

IDENTIFY NEEDED IMPROVEMENTS IN AIRCRAFT STRUCTURAL DESIGN

METHODOLOGY AND DEFICIENCIES IN AIRCRAFT STRUCTURES AND MATERIALS TECHNOLOGY THROUGH STRUCTURAL DESIGN STUDIES OF ADVANCED AIRCRAFT. IMPROVE THE AIRCRAFT DESIGN PROCESS THROUGH DEVELOPMENT OF COMPUTER METHODS AND PROGRAMS FOR ACCURATE ANALYSIS AND RAPID, OPTIMUM DESIGN OF STRUCTURAL COMPONENTS. IMPROVE THE TECHNOLOGY BASE FOR DESIGN OF SAFE, RELIABLE AIRCRAFT STRUCTURES THROUGH ANALYTICAL AND EXPERIMENTAL RESEARCH TOWARD ACCURATE PREDICTION OF FRACTURE OF AIRCRAFT STRUCTURES CONTAINING NOTCHES AND CRACKS AND OF BUCKLING STRENGTH OF IMPERFECT SHELL STRUCTURES. DEVELOP THE DESIGN TECHNOLOGY OF DEPLOYABLE AIRCRAFT COMPONENTS THROUGH ANALYSIS AND EXPLORATORY EXPERIMENTAL RESEARCH.

RTOP NO. 126-14-16 TITLE: STRUCTURAL DESIGN FOR ADVERSE ENVIRONMENTS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

AN ATTEMPT WILL BE MADE TO BROADEN THE FRACTURE MECHANICS APPROACH TO PREDICTING METAL FAILURE TO INCLUDE THE CHANGES IN BEHAVIOR RESULTING FROM EXPOSURE TO ENVIRONMENTS WHICH CAUSE EMBRITTLEMENT OF THE METAL. FOR THIS PURPOSE A CORRELATION OF EXPERIMENTAL DATA ON HYDROGEN EMBRITTLEMENT WITH DEVELOPED ANALYTICAL MODELS WILL BE SOUGHT. FOR THE AIRCRAFT DESIGNER, SUCCESSFUL EXTENSION OF THE FRACTURE MECHANICS APPROACH WOULD BE EXTREMELY BENEFICIAL ESPECIALLY SINCE THERE ARE AT PRESENT NO REALLY SATISFACTORY CRITERIA FOR EVALUATING THE ROLE OF ENVIRONMENTAL EMBRITTLEMENT IN MATERIAL SELECTION AND USE.

RTOP NO. 126-14-17 TITLE: COMPOSITES
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

FILAMENTARY COMPOSITE STRUCTURES EMPLOYING ADVANCED, HIGH MODULUS MATERIALS (BORON, GRAPHITE, TUNGSTEN, ETC.), IN METAL AND NON-METAL MATRICES, ARE RAPIDLY COMING INTO USE ON HYPERSONIC AIRCRAFT; HOWEVER, THE PRESENT AVAILABLE STRUCTURAL MATERIALS UTILIZED FOR AIRCRAFT CONSTRUCTION IS MARGINAL IN ACHIEVING THE NECESSARY STRENGTH TO WEIGHT. MSFC IS DEVELOPING FABRICATION METHODS AND PROCESSES FOR UTILIZING HIGH STRENGTH FIBERS FOR VARIOUS APPLICATIONS IN HIGH STRENGTH TO WEIGHT COMPOSITE STRUCTURES. PRELIMINARY PROGRAMS HAVE ALREADY BEEN ESTABLISHED IN BORON AND GRAPHITE FIBER UTILIZING VARIOUS MATRICES AND COMBINATIONS TO ACHIEVE THE DESIRED STRENGTH TO WEIGHT RATIO. THIS PROPOSED EFFORT WILL PROVIDE THE NECESSARY TECHNOLOGY TO DEVELOP FABRICATION AND INSPECTION TECHNIQUES FOR METALLIC STRUCTURES REINFORCED WITH FILAMENTARY COMPOSITES WHICH COULD BE UTILIZED IN SPECIFIC AREAS OF PRESENT AND FUTURE AIRCRAFT AND SPACE VEHICLES. ALSO, THIS PROGRAM WILL PROVIDE AN INTEGRATED EFFORT LEADING TOWARD THE SUCCESSFUL DEVELOPMENT OF SELECTED NDT METHODS, TECHNIQUES, AND STANDARDS TO BE APPLIED IN THE EVALUATION OF ADVANCED FILAMENTARY COMPOSITES.

RTOP NO. 126-14-17 TITLE: COMPOSITES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THIS RESEARCH EFFORT IS PROPOSED TO DEVELOP THE TECHNOLOGY THAT WILL PERMIT EARLY UTILIZATION AND EXPLOITATION OF ADVANCED FILAMENTARY COMPOSITES IN AIRCRAFT STRUCTURES THEREBY ACHIEVING SIGNIFICANT IMPROVEMENT IN THE STRUCTURAL PERFORMANCE. THE WORK CONSISTS OF THE FOLLOWING: 1. DEVELOPMENT OF CONCEPTS AND FABRICATION TECHNOLOGY FOR REINFORCEMENT OF METAL STRUCTURES WITH ADVANCED FILAMENTARY COMPOSITES 2. UNDERTAKING STUDIES TO DETERMINE THE FEASIBILITY AND TO PREPARE PLANS FOR UTILIZING ADVANCED FILAMENTARY COMPOSITES IN COMMERCIAL OR MILITARY AIRCRAFT STRUCTURES 3. STUDY OF MECHANICS OF FIBER REINFORCED COMPOSITES. BOTH IN-HOUSE AND CONTRACTUAL EFFORTS WILL BE MADE. THE RESULTS OF THESE EFFORTS WILL PROVIDE NEW TECHNICAL INFORMATION AND WILL DEVELOP CONFIDENCE REQUIRED TO MAKE EARLY APPLICATION OF FILAMENTARY COMPOSITES IN BOTH SUBSONIC AND SUPERSONIC AIRCRAFT STRUCTURES.

RTOP NO. 126-14-18 TITLE: FLIGHT LOADS MEASUREMENT TECHNIQUES
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: JENKINS, J. M. TEL. 805-258-3311
TECHNICAL SUMMARY

PROBLEMS HAVE OCCURRED WHEN FLIGHT-LOADS MEASUREMENTS HAVE BEEN REQUIRED ON AIRCRAFT WHICH ARE SUBJECT TO SIGNIFICANT AERODYNAMIC HEATING. THE AERODYNAMIC HEATING OF FLIGHT STRUCTURES INDUCES NONUNIFORM TEMPERATURE FIELDS THROUGHOUT THE STRUCTURE. THE NONUNIFORM TEMPERATURE FIELDS LEAD TO LARGE INDUCED THERMAL STRESSES WHICH ARE SENSED BY THE STRAIN GAGES. IF THE OBJECTIVE IS TO MEASURE AERODYNAMIC LOADS ONLY, THEN THE UNWANTED TEMPERATURES INDUCED STRAIN-GAGE OUTPUTS MUST BE ACCOUNTED FOR AND DEDUCTED FROM FLIGHT DATA. THIS OPERATION IS TO BE CONDUCTED BY GROUND-TEMPERATURE SIMULATION OF THE AERODYNAMIC HEATING, MEASURING THE THERMAL RESPONSES OF THE STRAIN GAGES AND THEN UTILIZING THIS INFORMATION AS A THERMAL CALIBRATION FOR CORRECTED PURPOSES.

RTOP NO. 126-15-10 TITLE: BEARINGS, SEALS, GEARS, SHAFTING,
LUBRICATION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: JOHNSON, R. L. TEL. 216-433-6464
TECHNICAL SUMMARY

BASIC MATERIALS, DEVELOPMENT, DESIGN THEORY, ANALYSIS AND EXPERIMENTATION WILL BE PERFORMED FOR EXTREME CONDITIONS WITH LUBRICANTS, LUBRICATION SYSTEMS, COMPONENT MATERIALS AND COMPONENT DESIGNS FOR BEARINGS, SEALS, GEARS AND SHAFTING OF ADVANCED AIRCRAFT TURBINE ENGINES TO ACHIEVE EFFICIENT PERFORMANCE, RELIABILITY AND EXTENDED LIFE.

RTOP NO. 126-15-11 TITLE: ATMOSPHERIC NUCLEAR PROPULSION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ROM, F. E. TEL. 216-433-6266
TECHNICAL SUMMARY

ANALYTICAL AND LIMITED EXPERIMENTAL INVESTIGATIONS WILL BE CARRIED OUT TO ASSESS THE FEASIBILITY OF SAFE, PRACTICAL LARGE SUBSONIC NUCLEAR AIRCRAFT. THE EMPHASIS ON THE STUDY IS PLACED ON (1) SAFETY, (2) LONG LIFE POWERPLANT COMPONENTS, AND (3) INTEGRATED POWERPLANT DESIGNS FOR AIRCRAFT AND SURFACE EFFECT VEHICLES. (1). THE SAFETY RESEARCH IS DIRECTED TOWARD DEVELOPING METHODS FOR PREVENTING THE RELEASE OF FISSION PRODUCTS DURING AND AFTER MAJOR ACCIDENTS BY CONTAINING THE REACTOR WITHIN A CONTAINMENT VESSEL DURING AND AFTER A HIGH VELOCITY IMPACT. (2). RESEARCH WILL BE DIRECTED TOWARD A REACTOR FUEL THAT CAN ACHIEVE BURNUP OF OVER 10 PERCENT AT OPERATING CONDITIONS. (3). THE WORK ON INTEGRATED POWERPLANTS IS DIRECTED TOWARD PROVIDING REALISTIC WEIGHT AND PERFORMANCE FOR THE COMPLETE SYSTEMS FOR AIRCRAFT AND SURFACE EFFECT VEHICLES.

RTOP NO. 126-15-12 TITLE: ENGINE POLLUTANTS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVES INCLUDE FUNDAMENTAL EXPERIMENTAL AND ANALYTICAL STUDIES OF THE MECHANISMS AND RATE OF NUCLEATION, GROWTH, AND CONSUMPTION OF SOOT IN HYDROCARBON BURNING COMBUSTION SYSTEMS. A LIGHT-SCATTERING APPARATUS IS EMPLOYED TO DETERMINE CARBON PARTICLE SIZE AND NUMBER CONCENTRATION IN A WELL DEFINED HYDROCARBON FLAME AS A FUNCTION OF THE VERTICAL DIMENSION. THIS WORK IS BEING PURSUED IN ORDER TO PRODUCE EXPRESSIONS FOR THE RATE OF FORMATION AND BURNOUT OF THE SOOT PARTICLES.

RTOP NO. 126-15-12 TITLE: POLLUTION CONTROL
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ROUDEBUSH, W. TEL. 216-433-4000
TECHNICAL SUMMARY

MEASUREMENTS OF POLLUTANTS WILL BE MADE IN THE EXHAUST OF TURBOJET COMBUSTORS OVER A RANGE OF COMBUSTOR PRESSURES, INLET TEMPERATURES, REFERENCE VELOCITIES AND FUEL-AIR RATIOS. THE POLLUTANTS MEASURED WILL INCLUDE PARTICULATES (SMOKE), NITRIC OXIDE, CARBON MONOXIDE AND HYDRO-CARBONS. TESTS WILL BE MADE USING EXISTING COMBUSTORS AS WELL AS ADVANCED DESIGN RESEARCH COMBUSTORS. AN EFFORT WILL BE MADE TO CORRELATE THE POLLUTANTS PRESENT WITH COMBUSTOR DESIGN AND OPERATING CONDITIONS. PRELIMINARY IN-HOUSE INVESTIGATIONS WILL BE CONDUCTED WITH SPECIAL COMBUSTOR DESIGNS TO DETERMINE THEIR EFFECTIVENESS IN REDUCING POLLUTION. TWO OF THESE COMBUSTOR DESIGNS ARE AS FOLLOWS: (1) A SHORT-DWELL-TIME COMBUSTOR WHICH SHOULD SERVE TO REDUCE NO EMISSION; (2) A STAGED-FUEL COMBUSTOR WITH ENRICHED PRIMARY ZONE AT IDLE CONDITIONS, WHICH SHOULD SERVE TO REDUCE CO AND HYDROCARBON EMISSIONS AT IDLE CONDITIONS. CONTRACTS WILL BE LET FOR

MORE DETAILED INVESTIGATION OF THOSE COMBUSTOR DESIGNS WHICH APPEAR PROMISING IN THE ABOVE IN-HOUSE PRELIMINARY INVESTIGATIONS. ONE SUCH CONTRACT IS PLANNED DURING FY 1971.

RTOP NO. 126-15-13 TITLE: ADVANCED PROPULSION SYSTEMS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: WEBER, R. J. TEL. 216-433-6605
TECHNICAL SUMMARY

DESIRABLE DESIGN CHARACTERISTICS OF VARIOUS FUTURE AIRCRAFT AND THEIR ASSOCIATED PROPULSION SYSTEMS WILL BE STUDIED. CYCLE ANALYSES AND WEIGHT ESTIMATES FOR A VARIETY OF ENGINE DESIGNS WILL BE COMBINED WITH STRUCTURAL AND AERODYNAMIC ESTIMATES FOR REPRESENTATIVE AIRFRAMES. RESULTS WILL PROVIDE COMPARISONS AND EVALUATIONS OF VARIOUS PROPULSION SYSTEMS IN MISSIONS OF INTEREST.

RTOP NO. 126-15-14 TITLE: PERFORMANCE OF HIGH PERFORMANCE AIRCRAFT
PROPULSION SYSTEMS
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: BELLMAN, D. R. TEL. 805-258-3311
TECHNICAL SUMMARY

INTERACTIONS BETWEEN A JET ENGINE AND AN AIRFRAME CAN HAVE SIGNIFICANT EFFECTS ON THE AIRCRAFT AND ENGINE PERFORMANCE PARTICULARLY FOR SUPERSONIC AIRCRAFT. STUDIES OF SUCH EFFECTS MUST BE DONE IN FULL SCALE FLIGHT BECAUSE UNCERTAIN SCALING FACTORS AND A LACK OF SUITABLY SIZED SUPERSONIC GROUND FACILITIES. FLIGHT TESTS ARE PLANNED FOR THE YF-12 AIRPLANE AND POSSIBLY THE F-14 AT A LATER DATE. OF PARTICULAR INTEREST IN THE CASE OF THE YF-12 IS THE AFFECT ON EXTERNAL NACELLE AND WING FLOW OF THE VARIOUS BLEED AND BYPASS FLOWS FROM THE INLET. ALSO, IT IS PLANNED TO STUDY THE EJECTOR NOZZLE AND COMPARE RESULTS WITH PREVIOUSLY OBTAINED DATA FROM THE F-111A AIRPLANE.

RTOP NO. 126-15-15 TITLE: SMALL GAS TURBINE ENGINES
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: GOLD, H. TEL. 216-433-6684
TECHNICAL SUMMARY

STUDIES ARE BEING MADE OF: (1) METHOD FOR ACHIEVING DRASTIC REDUCTION OF THE PRODUCTION COST OF SMALL GAS TURBINE ENGINES FOR USE IN AIRCRAFT WHICH DO NOT REQUIRE MAXIMUM ACHIEVABLE ENGINE PERFORMANCE, AND (2) METHODS OF IMPROVING THE CURRENTLY ACHIEVABLE PERFORMANCE OF SMALL GAS TURBINE ENGINES FOR USE IN AIRCRAFT WHERE THE HIGHEST PERFORMANCE IS OF GREAT IMPORTANCE. THE COST REDUCTION STUDY IS BEING MADE TO ESTABLISH A GENERAL BASE OF LOW-COST ENGINE TECHNOLOGY WHICH CAN BE DIRECTLY APPLIED TO TURBOJET AND TURBOFAN ENGINES IN THE 500 TO 1000 POUND THRUST RANGE. SUCH ENGINES WOULD BE EMINENTLY SUITABLE FOR APPLICATION TO A WIDE RANGE OF MISSILES AND DRONES AND TO GENERAL AVIATION AIRCRAFT WHERE IN BOTH CASES USE OF GAS TURBINE ENGINES IS CURRENTLY PROHIBITED BY THEIR VERY HIGH

PRODUCTION COST. CONTRIBUTION TO SMALL GAS TURBINE ENGINE COST REDUCTION TECHNOLOGY IS BEING MADE BY SIMPLIFICATION OF THE ENGINE CONFIGURATIONS, REDUCTION IN THE SIZE AND THE NUMBER OF STAGES REQUIRED AND USE OF LOW COST MATERIALS. IN ADDITION, USE OF NOVEL CONSTRUCTION AND FABRICATION TECHNIQUES FOR AXIAL FLOW COMPRESSOR AND TURBINES IS BEING INVESTIGATED. IN THE INVESTIGATION OF SMALL COMPRESSORS AND TURBINES SUITABLE FOR LOW POWER GAS TURBINE ENGINES, PRINCIPAL CONCERN IS THE MAINTENANCE OF HIGH AERODYNAMIC PERFORMANCE UNDER MORE SEVERE REQUIREMENTS (PRESSURE RATIOS, TEMPERATURES, ETC.) AND IN THE SMALL SIZE RANGE ENCOUNTERED IN THESE APPLICATIONS. BOTH AXIAL AND RADIAL INFLOW TURBINES ARE BEING INVESTIGATED WHEREAS PRINCIPAL EMPHASIS IS BEING PLACED ON CENTRIFUGAL AND MIXED FLOW COMPRESSORS.

RTOP NO. 126-15-16 TITLE: AERONAUTICAL ENGINE MATERIALS RESEARCH
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: AULT, G. M. TEL. 216-433-6387
TECHNICAL SUMMARY

THIS PROGRAM INVOLVES RESEARCH ON A WIDE VARIETY OF MATERIALS BEING CONSIDERED FOR USE IN FUTURE AIRCRAFT ENGINES. THE GENERAL OBJECTIVES OF THIS RESEARCH ARE: 1. TO IMPROVE THE PROPERTIES OF EXISTING MATERIALS USED FOR AERONAUTIC ENGINE APPLICATIONS TO PERMIT THEIR USE AT HIGHER TEMPERATURES FOR LONGER TIMES, IN LIGHTER WEIGHT CONFIGURATIONS, AND WITH GREATER RELIABILITY. 2. TO INVESTIGATE AND DEVELOP NEW MATERIALS, PROCESSING METHODS, AND ANALYTICAL PERFORMANCE PREDICTION METHODS THAT ARE SUPERIOR TO EXISTING ONES. THIS PROGRAM WILL BE DONE UNDER CONTRACTS WITH VARIOUS INDUSTRIAL AND ACADEMIC RESEARCH LABORATORIES. IN ADDITION, THIS PROGRAM CLOSELY COUPLES WITH OTHER IN-HOUSE WORK CONDUCTED UNDER RTOPS 129-03-(20, 21, 23, AND 28).

RTOP NO. 126-61-10 TITLE: ATMOSPHERIC PARAMETERS
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: EHERNBERGER, L. J. TEL. 805-258-3311
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK IS THE DEFINITION OF THE ATMOSPHERIC CONDITIONS IN WHICH TURBULENCE, TEMPERATURE, TRANSIENTS, POTENTIAL PRESSURE ALTIMETRY PROBLEMS, AND EXCESSIVE WIND SHEARS OCCUR. THE MAJOR EMPHASIS IN THE ATMOSPHERIC ENVIRONMENT OF SUPERSONIC AIRCRAFT. DEVELOPMENT AND ACQUISITION OF SENSORS NEEDED TO MEASURE THESE PHENOMENA ARE ALSO INCLUDED. RESULTS OF THIS WORK WILL BE APPLICABLE TO AIRCRAFT SYSTEMS DESIGN AS WELL AS FLIGHT OPERATIONS ROUTING AND SCHEDULING. OBSERVATIONS OF THESE PHENOMENA ARE OBTAINED FROM INSTRUMENTED AIRCRAFT TEST FLIGHTS. THE ASSOCIATED METEOROLOGICAL CONDITIONS ARE ANALYZED AND STUDIED BOTH IN-HOUSE AND ON-CONTRACT.

RTOP NO. 126-61-10 TITLE: ATMOSPHERIC PARAMETERS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

THERE ARE TWO PRACTICAL WAYS TO PROBE CAT--VIA (1) INSTRUMENTATION ABOARD AIRCRAFT AND (2) THE FPS-16 RADAR/JIMSPHERE BALLOON WIND SENSOR SYSTEM. THE FORMER YIELDS EXTENSIVE INFORMATION ABOUT THE HORIZONTAL STRUCTURE OF CAT, WHILE THE LATTER PROVIDES MEANINGFUL INFORMATION ABOUT THE VERTICAL STRUCTURE OF CAT AND THE PHENOMENA THAT GENERATE CAT. EXTENSIVE EFFORTS HAVE BEEN MADE BY VARIOUS INVESTIGATORS TO ANALYZE THE AIRCRAFT OBSERVATIONS, WHILE VERY LITTLE EFFORT HAS BEEN DEVOTED TO THE ANALYSIS OF JIMSPHERE DATA IN A CAT CONTEXT. ACCORDINGLY, THE OBJECTIVE OF THIS REQUEST IS TO EXPLOIT THE FPS-16 RADAR/JIMSPHERE BALLOON SYSTEM TO ACHIEVE A BETTER UNDERSTANDING OF ATMOSPHERIC TURBULENCE FOR THE DEFINITION OF ATMOSPHERIC PARAMETERS FOR USE IN AIRCRAFT DESIGN AND OPERATION. THIS WILL BE ACCOMPLISHED BY ESTABLISHING THE RELATIONSHIP BETWEEN HIGH RESOLUTION WIND AND TEMPERATURE PROFILES AND AIRCRAFT OBSERVATIONS OF CAT AND IN TURN ESTABLISHING THE RELATIONSHIP BETWEEN THESE PROFILES AND SYNOPTIC AND MESOSCALE CONDITIONS THAT PRODUCE THE DETAILS ON THESE WIND AND TEMPERATURE PROFILES. THE RESULTS OF THIS RESEARCH SHOULD BETTER ESTABLISH THE RELATIONSHIP BETWEEN CAUSE AND EFFECT WITH REGARD TO IMPROVING CURRENT CAT FORECASTING PROCEDURES BESIDES AIDING IN THE DEVELOPMENT OF AIRCRAFT DESIGN CRITERIA AND REMOTE CAT SENSING SYSTEMS.

RTOP NO. 126-61-10 TITLE: ATMOSPHERIC PARAMETERS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: MCGOWAN, W. A. TEL. 202-962-4601
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO IMPROVE OUR UNDERSTANDING OF THE MORPHOLOGY OF SEVERE LOCAL STORMS AND LOW LEVEL WIND TO PROVIDE THE TECHNOLOGY FOR ADEQUATE AIRCRAFT DESIGN AND SAFE OPERATING PROCEDURES IN THE ENVIRONMENT. THEORETICAL ANALYSIS AND ATMOSPHERIC MEASUREMENTS USING INSTRUMENTED AIRCRAFT, BALLOONS, PHOTO TRIANGULATION TECHNIQUES, AND RADARS WILL BE USED TO DEFINE THE PHYSICAL AND ELECTROMAGNETIC CHARACTERISTICS OF THE STORM. METEOROLOGICAL TOWERS WILL BE USED IN THE LOW LEVEL WIND STUDIES. THE INFORMATION WILL PROVIDE THE METEOROLOGIST, AIRCRAFT DESIGNER, AND AIRCRAFT PILOT DATA FOR SAFE, ECONOMICAL OPERATIONS. THE RESEARCH WILL BE CARRIED OUT UNDER NASA CONTRACTS WITH THE NATIONAL SEVERE STORMS LABORATORY, ESSA, AND THE VIRGINIA POLYTECHNIC INSTITUTE.

RTOP NO. 126-61-10 TITLE: ATMOSPHERIC PARAMETERS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE IS TO OBTAIN DATA ON THOSE CHARACTERISTICS OF THE ATMOSPHERE WHICH AFFECT THE DESIGN AND OPERATION OF AIRCRAFT.

ATMOSPHERIC PRECIPITATES, SUCH AS RAINDROPS AND HAILSTONES, WILL BE STUDIED TO MEASURE THE EFFECT OF THEIR IMPACT ON AIRFRAMES. ATMOSPHERIC WINDS, WIND SHEAR, AND TURBULENCE WILL BE STUDIED; THESE CHARACTERISTICS ARE OF PARTICULAR CONCERN BECAUSE THEY AFFECT THE CONTROL, STABILITY, AND THE STRUCTURAL LOADS ON AIRCRAFT. ALL STUDIES WILL INCLUDE THEORETICAL ANALYSES AND EXPERIMENTS. THE RESULTING DATA WILL BE COMPILED IN A FORM SUITABLE FOR APPLICATION TO PROBLEMS WHICH OCCUR IN THE DESIGN AND OPERATION OF AIRCRAFT.

RTOP NO. 126-61-11 TITLE: AIRCRAFT OPERATING EXPERIENCES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

STATISTICAL DATA ON THE OPERATIONAL EXPERIENCES OF COMMERCIAL PASSENGER AND CARGO TRANSPORTS, GENERAL AVIATION AIRPLANES, AND RESEARCH TYPE AIRPLANES, AND HELICOPTERS ARE BEING COLLECTED AND ANALYZED. THE DATA ARE COLLECTED DURING ROUTINE OPERATIONS OF THE AIRPLANES BY USE OF NASA INSTRUMENTATION. THE DATA FROM THE COMMERCIAL AND GENERAL AVIATION AIRPLANES ARE OBTAINED THROUGH COOPERATIVE PROGRAMS WITH THE MANUFACTURERS, AIRLINES, AND PRIVATE OWNERS. THE DATA PROVIDE INFORMATION ON THE GROUND AND FLIGHT LOADS, AIRSPEED AND ALTITUDE OPERATING PRACTICES, THE TURBULENCE ENVIRONMENT, AND ON UNUSUAL EVENTS SUCH AS LOSS OF CONTROL IN TURBULENCE, COLLISION AVOIDANCE MANEUVERS, AND AUTOPILOT INDUCED MANEUVERS. THE INFORMATION OBTAINED PROVIDES A CONTINUED BASIS FOR COMPARING ACTUAL AIRPLANE OPERATIONS WITH THE CONCEPTS USED IN DESIGN, FOR DETECTING UNANTICIPATED OPERATIONAL ASPECTS, AND PROVIDES A RESERVOIR OF DATA USEFUL IN THE DESIGN AND DEVELOPMENT OF AIRWORTHINESS REQUIREMENTS FOR NEW TYPES OF AIRPLANES. JUSTIFICATION: A DETAILED KNOWLEDGE OF THE OPERATING PRACTICES, THE LOADS EXPERIENCED, AND THE OPERATIONAL ENVIRONMENT OF VARIOUS TYPES OF AIRCRAFT DURING ROUTINE OPERATIONS IS REQUIRED FOR: A. THE CONTINUAL REASSESSMENT OF THE MINIMUM AIRWORTHINESS REQUIREMENTS FOR CURRENT AIRCRAFT B. THE DEVELOPMENT OF AIRWORTHINESS REQUIREMENTS FOR NEW TYPES OF AIRCRAFT AND TYPES OF OPERATIONS C. USE BY MANUFACTURERS IN THE DESIGN AND TESTING OF NEW AIRCRAFT.

RTOP NO. 126-61-12 TITLE: TIRE TRACTION, BRAKING
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE PRESENCE OF WATER OR SLUSH ON PREPARED FIELDS AND THE TYPE OF SOIL ON UNPREPARED FIELDS CAN CONTRIBUTE TO UNSAFE HANDLING CONDITIONS DURING TAXIING, STOPPING, AND STEERING AIRCRAFT. ALSO THE ROUGHNESS OF HARD SURFACE AIRFIELDS, AND OBSTRUCTIONS SUCH AS ARRESTING GEAR CABLES AND PLAT HEADS ON AIRCRAFT CARRIER DECKS CONTRIBUTE TO HIGH LANDING AND TAXIING LOADS. THE OBJECTIVE OF THESE INVESTIGATIONS ARE TO OBTAIN A FUNDAMENTAL UNDERSTANDING OF THESE PHENOMENA WITH A VIEW TOWARD THEIR SOLUTION. THIS WORK WILL BE APPLICABLE TO IMPROVED DESIGN OF AIRCRAFT LANDING GEARS AND BRAKING

SYSTEMS AS WELL AS IMPROVEMENT IN RUNWAY DESIGN.

RTOP NO. 126-61-13 TITLE: HAZARD AVOIDANCE AND ELIMINATION

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE BASIC TECHNOLOGY DATA FOR THE IMPROVEMENT OF THE LEVEL OF SAFETY IN AIRCRAFT OPERATIONS. TECHNICAL ASSISTANCE IS BEING PROVIDED TO VARIOUS AGENCIES HAVING SAFETY OF FLIGHT PROBLEMS. METHODS OF DETECTING CLEAR AIR TURBULENCE ARE BEING INVESTIGATED. THE CHARACTERISTICS OF WING TRAILING VORTICES SHED AT HIGH ALTITUDES AND IN CLOSE PROXIMITY OF THE GROUND ARE BEING STUDIED.

RTOP NO. 126-61-13 TITLE: HAZARD AVOIDANCE AND ELIMINATION

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

TWO PHENOMENA, BOTH OF WHICH ARE TURBULENCE, WILL BE INVESTIGATED TO PROVIDE BASIC TECHNOLOGY DATA FOR THE IMPROVEMENT OF THE OPERATIONAL SAFETY OF CIVIL AND MILITARY AIRCRAFT FOR THE PREVENTION OF CATASTROPHIC ACCIDENTS. SPECIFICALLY, A GROUND BASED SYSTEM FOR THE DETECTION OF AIRCRAFT TRAILING VORTICES, AND AN AIRBORNE SYSTEM FOR THE DETECTION OF CLEAR AIR TURBULENCE (CAT) WILL BE DEVELOPED. THE PRIMARY EMPHASIS WILL BE PLACED ON THE DEVELOPMENT OF AN OPERATIONAL TRAILING VORTEX DETECTION SYSTEM. USING THE LASER HETERODYNE APPROACH, AN AIRBORNE CAT DETECTION SYSTEM WILL BE DEVELOPED INTO A FLYABLE SYSTEM. THE TOTAL SYSTEM WILL BE PROOF TESTED ON THE GROUND THEN UNDERGO FLIGHT TESTING. A SIMILAR APPROACH WILL BE USED IN THE DEVELOPMENT OF A SYSTEM TO MEASURE THE VORTICES CREATED BY FAST, LARGE AND HEAVY AIRCRAFT. BOTH TURBULENCE DETECTION SYSTEMS ARE REQUIRED FOR THE COMFORT AND SAFETY OF PASSENGERS AND CREWS. IN THE CASE OF THE CAT, IT IS BECOMING EVEN MORE IMPORTANT ESPECIALLY IN VIEW OF THE LARGE JUMBO JETS WHICH WILL CARRY HUNDREDS OF PASSENGERS ON A SINGLE FLIGHT. UNFORTUNATELY, THESE JUMBO JETS INCREASE THE PROBLEM OF TRAILING VORTEX TURBULENCE. IN THE PAST THE VORTEX PROBLEM CREATED HAZARDOUS CONDITIONS FOR "SMALL" AIRCRAFT ONLY; HOWEVER, WITH THE JUMBO JETS, THE VORTEX TURBULENCE PROBLEM NOW IS IMPOSED UPON WHAT WERE CONSIDERED TO BE "MEDIUM AND LARGER" AIRCRAFT.

RTOP NO. 126-61-13 TITLE: HAZARD AVOIDANCE AND ELIMINATION

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: CHIARITO, P. T. TEL. 216-433-6941

TECHNICAL SUMMARY

OBJECTIVE: TO PROVIDE BASIC DATA FOR THE IMPROVEMENT OF THE OPERATIONAL SAFETY OF CIVIL AND MILITARY AIRCRAFT. APPROACH: THROUGH NASA SUPPORTED RESEARCH, WHICH COMPLEMENTS RESEARCHES CONDUCTED BY OTHER SEGMENTS OF THE AVIATION COMMUNITY, PROVIDE

DEVICES AND TECHNIQUES WHICH OVERCOME OPERATIONAL PROBLEMS PRESENTED BY THE DESIRE TO IMPROVE THE SAFETY OF AIRPLANE OPERATIONS WHILE EXTENDING THE MISSION OF THE AIRPLANE AND IMPROVING THE ECONOMICS OF ITS OPERATION.

RTOP NO. 126-61-13 TITLE: HAZARDS AVOIDANCE AND ELIMINATION
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

CANDIDATE ABLATIVE MATERIALS WILL BE EVALUATED AS BRAKE MATERIAL LININGS FOR HIGH SPEED AIRCRAFT AND MODIFIED IF NECESSARY TO IMPROVE PERFORMANCE OVER EXISTING BRAKE LINING MATERIALS. ELASTOMERIC COMPOUNDS WILL BE SYNTHESIZED AND EVALUATED AS CANDIDATE MATERIALS FOR IMPROVED AIRCRAFT TIRES. PYROLYSIS PRODUCTS OF FLUORINATED HYDROCARBON COMPOUNDS USED IN AIRCRAFT WILL BE ANALYZED TO DETERMINE THEIR TOXICITY LEVELS. OBJECTIVE OF THE PROGRAM IS TO PROVIDE IMPROVED PERFORMANCE OF AIRCRAFT AND GREATER OPERATIONAL SAFETY. WIND TUNNEL STUDIES OF TRAILING VORTEX FORMATION AND MODIFICATION ARE BEING PERFORMED UNDER RTOP 737-05-10.

RTOP NO. 126-61-13 TITLE: HAZARD AVOIDANCE AND ELIMINATION
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: ANDREWS, W. H. TEL. 805-258-3311
TECHNICAL SUMMARY

OPERATING PROBLEMS RELATED TO THE CURRENT AND FUTURE JET TRANSPORT AIRPLANES ARE BEING INVESTIGATED. HANDLING CHARACTERISTICS AND OPERATIONAL PROCEDURES RELATED TO POTENTIAL HAZARDS SUCH AS ATMOSPHERIC TURBULENCE, WING VORTEX WAKE, INSTRUMENT WEATHER, ETC., WILL BE EVALUATED. IN ADDITION, ABUSIVE OPERATIONAL PRACTICES AND CRITERIA PERTINENT TO FUTURE CERTIFICATION STANDARDS ARE INCLUDED FOR CONSIDERATION. CURRENT STUDIES ARE DIRECTED TO AN EVALUATION OF THE INFLUENCE OF THE WING VORTEX WAKE FROM LARGE TRANSPORTS ON AIRCRAFT SPACING IN THE AIR TRAFFIC SYSTEM. PRELIMINARY OPERATIONAL TESTS ARE BEING CONDUCTED WITH A VARIETY OF GENERATING AND PROBE AIRCRAFT TO ASSESS LOGICAL AIRWAYS SPACING CRITERIA. ADDITIONAL TESTING WILL BE PERFORMED FOLLOWING THE OPERATIONAL PHASE TO INVESTIGATE VARIOUS ASPECTS OF THE THEORETICAL DESCRIPTION OF THE WING WAKE BEHAVIOR.

RTOP NO. 126-61-13 TITLE: HAZARD AVOIDANCE AND ELIMINATION
ORGANIZATION: NASA HEADQUARTERS
MONITOR: MCGOWAN, W. A. TEL. 202-962-4601
TECHNICAL SUMMARY

THIS RESEARCH IS BEING UNDERTAKEN TO IMPROVE OUR UNDERSTANDING OF THE LIFE-CYCLE OF WARM FOG AND DEVELOP A METHOD TO EITHER MODIFY IT OR PREVENT ITS FORMATION. THE RESEARCH WILL BE PERFORMED UNDER NASA CONTRACT. THEORETICAL ANALYSIS, LABORATORY TESTS AND FIELD MEASUREMENTS OF NATURAL FOG AND ITS ENVIRONMENT WILL BE USED TO DEFINE THE PHYSICAL AND ELECTROMAGNETIC CHARACTERISTICS OF FOG. THIS

INFORMATION WILL BE USED TO DEVELOP CONCEPTS/TECHNIQUES FOR USE BY AIRPORT OPERATORS TO EITHER PREVENT FOG FROM FORMING OR IMPROVE VISIBILITY IN A FOG ONCE IT'S FORMED. WARM FOG OCCURRENCES IN THE AIRPORT AREA CAUSES DELAYS AND CANCELLATIONS WHICH ARE TROUBLESOME TO PASSENGERS AND COSTLY TO AIRPLANE OPERATORS, ESTIMATED BY THE AIR TRANSPORTATION ASSOCIATIONS TO BE ON THE ORDER OF \$100,000,000 PER YEAR. LOW VISIBILITY, ESPECIALLY IN THE AIRPORT AREAS, IS ALSO DETRIMENTAL TO SAFETY ASPECTS OF AIRCRAFT OPERATIONS.

RTOP NO. 126-61-14 TITLE: ENGINE AND PROPELLER NOISE
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: KRAMER, J. TEL. 216-433-6878
TECHNICAL SUMMARY

THE WORK IN THIS PROGRAM IS DIRECTED AT OBTAINING AN UNDERSTANDING OF THE DOMINANT NOISE SOURCES IN PROPULSION SYSTEMS FOR THREE TYPES OF AIRCRAFT - LONG RANGE SUBSONIC TRANSPORT, STOL TRANSPORT AND SUPERSONIC TRANSPORT AIRCRAFT. FOR THE LONG RANGE SUBSONIC TRANSPORT PROPULSION SYSTEMS THE AREAS OF INTEREST ARE THE NOISE GENERATED BY THE FAN, THE SUPPRESSION OF THE FAN NOISE BY ACOUSTICALLY TREATED NACELLES, AND THE LOW VELOCITY JET MIXING NOISE.

FOR STOL PROPULSION SYSTEMS THE CANDIDATE LIFT AUGMENTATION SYSTEMS (INTERNALLY BLOWN AND EXTERNALLY BLOWN FLAPS) ARE POTENTIAL SIGNIFICANT NOISE SOURCES. FOR SST PROPULSION HIGH PRESSURE RATIO, HIGH TEMPERATURE JET MIXING NOISE DOMINATES THE ENGINE NOISE OUTPUT.

RTOP NO. 126-61-14 TITLE: JET NOISE REDUCTION
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

THE GENERAL OBJECTIVES OF THIS TASK ARE TO DETERMINE (1) THE INFLUENCE OF VELOCITY DISTRIBUTION AT THE EXIT OF A NOZZLE, AND (2) THE INFLUENCE OF TURBULENCE, PARTICULARLY IN THE BOUNDARY LAYER, ON THE NOISE RADIATED FROM SUPERSONIC JETS DISCHARGING INTO THE ATMOSPHERE AT STAGNATION TEMPERATURES OF THE ORDER OF 3000 DEGREES F.

UNDERSTANDING THE MECHANISM OF NOISE GENERATION FROM SUCH JETS IS ESSENTIAL TO NOISE REDUCTION FROM TURBOJET ENGINES USED ON AIRCRAFT - PARTICULARLY AS APPLIED TO THE AFTERBURNING ENGINE OF THE SUPERSONIC TRANSPORT. EXPERIMENTAL MEASUREMENTS OF THE PERCEPTIVE NOISE LEVEL WILL BE MADE AT SELECTED LOCATIONS IN THE SURROUNDINGS OF JETS EMERGING FROM A ROCKET NOZZLE AND A NOZZLE CONTAINING HEATED AIR FLOW. FOR THE HEATED AIR TESTS COMPRESSED AIR WILL BE SUPPLIED BY AN EXISTING COMPRESSED AIR FACILITY AT PRESSURES ENCOUNTERED IN JET ENGINES AND THE AIR WILL BE HEATED BY BURNING A JET FUEL TO TEMPERATURES ALSO ENCOUNTERED IN TURBOJET ENGINES. EXPERIMENTS WILL BE CONDUCTED WITH AN UPSTREAM APPROACH SECTION IN WHICH TURBULENCE LEVELS AND GAS TEMPERATURES ARE ADJUSTABLE. VELOCITY DISTRIBUTIONS WILL BE DETERMINED FROM MEASUREMENTS OF PRESSURES AND TEMPERATURES OBTAINED WITH PROBES. FLUCTUATING QUANTITIES WILL BE MEASURED WITH GAGES AND CROSSED LASER BEAMS. OTHER METHODS OF DETERMINING FLUCTUATING QUANTITIES WILL BE INVESTIGATED. ROCKET ENGINE TESTS

WILL BE CONDUCTED USING SUPERSONIC NOZZLES WITH AN EXIT DIAMETER OF ABOUT 12 IN AND FLOW CONDITIONS RESEMBLING THOSE OF JET ENGINES. THE INFLUENCE OF COMBUSTION IN THE NOZZLE AND EXTERNAL FLOW WILL BE STUDIED BY REDUCING COMBUSTOR VOLUME TO THE EXTENT THAT COMBUSTION IS KNOWN TO BE INCOMPLETE AT THE NOZZLE EXIT. NOISE LEVEL AND PRESSURE FLUCTUATIONS WILL BE MEASURED.

RTOP NO. 126-61-14 TITLE: ENGINE AND PROPELLER NOISE
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

THE MOST DISTURBING AND DELETERIOUS BY-PRODUCT OF LARGE AIRCRAFT OPERATIONS IS THE INTENSE ACOUSTIC NOISE FIELD GENERATED BY THE EXHAUST FLOW OF THE PROPULSION SYSTEM (I.E., JET ENGINES, ETC.). THE RESULTANT ACOUSTIC ENVIRONMENT IS OF SUCH A MAGNITUDE, FOR INSTANCE, THAT IT DOMINATES THE STRUCTURAL AND ELECTRONIC DESIGN CONSIDERATIONS OF MODERN AIRCRAFT AND GROUND SUPPORT EQUIPMENT (GSE). ADDITIONALLY, IT PRESENTS AN OPERATIONAL HAZARD TO GROUND PERSONNEL AND TO THE COMMUNITIES SURROUNDING THE RESPECTIVE OPERATIONAL AREAS. THE SUBJECTIVE ASPECTS OF THE PSYCHOLOGICAL AND PHYSIOLOGICAL REACTIONS TO THIS INTENSE NOISE FIELD ARE EXTREMELY DIFFICULT TO ASSESS. OF COURSE, AS AIRCRAFT GREW IN SIZE THE MAGNITUDE AND THE COMPLEXITIES OF THE PROBLEMS ASSOCIATED WITH THEIR ACOUSTIC ENVIRONMENT GREW PROPORTIONATELY. ALL ASPECTS OF THE ACOUSTIC ENVIRONMENT SHOULD BE DEFINED AT THE EARLIEST POSSIBLE PHASE OF THE RESEARCH, DEVELOPMENT, OPERATIONAL CYCLE OF CURRENT AND FUTURE AIRCRAFT SYSTEMS (I.E., JUMBO JETS, SST, ETC.). IT IS OBVIOUS THAT THE IMPACT ON THE AIRCRAFT SYSTEMS, AND HENCE TOTAL COST WILL BE MUCH GREATER IF A FIX INSTEAD OF CURE PHILOSOPHY IS TAKEN WITH RESPECT TO THIS IMPORTANT DESIGN CONSIDERATION.

RTOP NO. 126-61-14 TITLE: ENGINE AND PROPELLER NOISE
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: MCLEOD, N. J. TEL. 805-258-3311
TECHNICAL SUMMARY

THE PRIMARY OBJECTIVES OF THESE STUDIES ARE TO MEASURE AND EVALUATE NEAR- AND FAR FIELD ACOUSTIC DATA, AND CORRELATE WITH PREDICTION TECHNIQUES TO AID IN THE CONTROL OF ACOUSTIC PHENOMENA FOR PRESENT AND FUTURE AEROSPACE VEHICLES. THESE INCLUDE STUDIES OF ENGINE NOISE DURING TAKEOFF AND LANDING, AND ITS EFFECTS ON THE VEHICLE AND THE VEHICLE'S SURROUNDINGS, AND BOUNDARY-LAYER NOISE AT VARIOUS FLIGHT CONDITIONS.

RTOP NO. 126-61-14 TITLE: ENGINE AND PROPELLER NOISE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE ACCOMPLISHED BY THE FOLLOWING:

(A) IDENTIFICATION AND EVALUATION OF THE SOURCES OF NOISE THAT ARE SIGNIFICANT UNDER VARIOUS OPERATING CONDITIONS OF JET ENGINES (INCLUDING EXHAUST JETS, FANS, COMPRESSORS, AND TURBINES) AND PROPELLERS (WITH AND WITHOUT DUCTS), WITH A VIEW TOWARD NOISE REDUCTION AT THE SOURCE BY DESIGN. SUCH FACTORS AS JET VELOCITY, TEMPERATURE, DENSITY AND TURBULENCE LEVEL; TIP SPEED, NUMBER OF BLADES, INFLOW ANGLES, SECTION CHARACTERISTICS, SURFACE ROUGHNESSES WAKE INTERACTIONS, ETC. FOR PROPELLERS, FANS, COMPRESSORS AND TURBINES WILL BE STUDIED TO DETERMINE THEIR EFFECTS ON THE GENERATED NOISE; (B) NOISE REDUCTION BY MEANS OF THE APPLICATION OF ACOUSTIC MATERIALS IN THE INLET, IN THE FAN DISCHARGE DUCTS, IN THE MAIN EXHAUST DUCT OF AN ENGINE OR BY THE APPLICATION OF JET EXHAUST NOISE SUPPRESSOR; (C) IDENTIFICATION AND EVALUATION OF THOSE FACTORS SIGNIFICANT IN THE ATTENUATION OF NOISE DURING PROPAGATION FROM AIR TO GROUND OR FROM GROUND TO GROUND SITUATIONS; (D) DEVELOPMENT OF ADEQUATE METHODS OF PREDICTION OF NOISE SPECTRA FROM AIRCRAFT POWER PLANTS UNDER VARIOUS OPERATING CONDITIONS AND AT VARIOUS DISTANCES. THIS WORK WILL BE ACCOMPLISHED BY MEANS OF THEORETICAL STUDIES, BY FULL-SCALE AIRCRAFT TESTS AND BY MODEL TESTS IN WIND TUNNELS AND SPECIAL TEST CELLS.

RTOP NO. 126-61-15 TITLE: SONIC BOOM EFFECTS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE TO IDENTIFY AND TO QUANTIFY THE DETRIMENTAL EFFECTS OF NOISE AND SONIC BOOMS ON GROUND BASED STRUCTURES AND EQUIPMENT IN ORDER THAT DESIGN AND OPERATIONAL PROCEDURES MAY BE DEvised TO MINIMIZE SUCH EFFECTS. THE EMPHASIS IS ON BUILDING STRUCTURES FOR WHICH VIBRATIONS, NOISE TRANSMISSION AND SUPERFICIAL DAMAGES DUE TO REPEATED LOADS, ARE OF PARTICULAR CONCERN.

THE DEVELOPMENT OF SIMULATORS IS ALSO INCLUDED. THIS WORK WILL BE ACCOMPLISHED BY MEANS OF THEORETICAL STUDIES, AS WELL AS BOTH MODEL COMPONENT AND FULL-SCALE TESTS INVOLVING AIRPLANE FLYOVERS, LABORATORY ACOUSTICAL EXCITATION AND THE USE OF SIMULATORS.

RTOP NO. 126-61-16 TITLE: INSTRUMENTATION-EVALUATION AND
DEVELOPMENT OF FLIGHT RESEARCH SENSORS
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: WEBB, L. D. TEL. 805-258-3311
TECHNICAL SUMMARY

THE ADVANCED TYPE RESEARCH FLIGHTS BEING CONDUCTED AT FRC REQUIRES THE USE OF NEW AND UNPROVEN TYPES OF SENSORS TO OBTAIN THE DESIRED RESEARCH MEASUREMENTS. THE OBJECTIVE OF THIS PROGRAM IS THE DESIGN DEVELOPMENT AND TESTING OF ADVANCED SENSORS PARTICULARLY WHEN THE WORK IS BEING DONE IN ADVANCE OF, OR APART FROM, THE VEHICLE ON WHICH IT WILL ULTIMATELY BE USED. EXAMPLES OF NEEDED SENSORS ARE ALTIMETERS FOR USE AT HIGH SPEEDS AND EXTREME ALTITUDES, MINIATURE PRESSURE TRANSDUCERS CAPABLE OF WITHSTANDING MACH 3 STAGNATION TEMPERATURES, PRESSURE SURVEY RAKES SUITABLE FOR MEASURING DYNAMIC

FLows, AND MINIATURE FLOW DIRECTION SENSORS FOR DETERMINING LOCAL FLOW ANGULARITIES. WHENEVER POSSIBLE "OFF-THE-SHELF" ITEMS WILL BE USED WITH FLIGHT SUITABILITY BEING DETERMINED IN FRC LABS. DEVELOPMENT OF NEW CONCEPTS WILL BE SPONSORED IF NO AVAILABLE DEVICES SUIT THE NEEDS.

RTOP NO. 126-61-16 TITLE: INSTRUMENTATION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

NEW CONCEPTS, TECHNIQUES, AND ADVANCED TECHNOLOGY WILL BE INVESTIGATED AND DEVELOPED TO IMPROVE, REPLACE, OR TO FILL VOIDS IN RESEARCH INSTRUMENTATION TECHNIQUES AND SYSTEMS REQUIRED FOR THE STUDY OF PROBLEMS RELATING TO EFFICIENT AND SAFE OPERATION OF ALL CLASSES OF AIRCRAFT. EFFORT WILL BE CONCENTRATED IN CLEAR-AIR TURBULENCE DETECTION AND WARNING, PILOT DISPLAYS, SENSORS, AND DATA SYSTEMS.

RTOP NO. 126-62-10 TITLE: HANDLING QUALITIES
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: REDIESS, H. A. TEL. 805-258-3311
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO STUDY AND DOCUMENT THE RELATIONSHIP BETWEEN THE STABILITY AND CONTROL CHARACTERISTICS OF AIRPLANES IN GENERAL AND THE PILOT'S ASSESSMENTS OF THE HANDLING QUALITIES, THROUGH THE USE OF SIMULATORS (BOTH FIXED-BASED AND AIRBORNE) AND THE ACTUAL AIRPLANES.

RTOP NO. 126-62-10 TITLE: HANDLING QUALITIES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

TO STUDY ANALYTICALLY AND BY THE USE OF FLIGHT SIMULATORS THE HANDLING QUALITIES (ASSOCIATED WITH VEHICLE DYNAMICS AND CONTROL EFFECTIVENESS) AND CONTROL SYSTEMS OF PROPOSED SUPERSONIC AND TACTICAL AIRCRAFT AND OTHER AEROSPACE VEHICLES. TO INCLUDE DIGITAL SIMULATIONS AND THEORETICAL ANALYSES OF THE AERIAL COMBAT PROBLEM AND THE CONTROL OF AIRCRAFT IN TURBULENCE. ALL OF THESE INVESTIGATIONS ARE DESIGNED TO EXPAND FUNDAMENTAL KNOWLEDGE ON AIRCRAFT HANDLING QUALITIES AS THEY ARE IMPORTANT TO THE ADVANCEMENT OF AERODYNAMIC FLIGHT.

RTOP NO. 126-62-10 TITLE: HANDLING QUALITIES AND FLIGHT DYNAMICS
THEORY

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: KLEIN, H. P. TEL. 415-961-1111

TECHNICAL SUMMARY

SOME OF THE MAJOR FACTORS WHICH ARE INVOLVED IN THE ACCEPTANCE OF TRANSPORT AIRCRAFT INTO OPERATION BY THE COMMERCIAL AIRLINES ARE THE HANDLING QUALITIES, THE RIDE QUALITIES, AND THE PERCEIVED NOISE WITHIN THE SURROUNDING AREA OF AN AIRPORT. THE RESPONSE OF A PARTICULAR AIRCRAFT TO AERODYNAMIC DISTURBANCES GREATLY AFFECT THE HANDLING AND RIDE QUALITIES, AND THE FLIGHT TRAJECTORY DURING CLIMBOUT INFLUENCES THE PERCEIVED NOISE IN THE GROUND TRACK OF THE AIRCRAFT. A SERIES OF RESEARCH STUDIES WILL BE CARRIED OUT TO IDENTIFY THE MAJOR FACTORS CONTRIBUTING TO THE HANDLING AND RIDE QUALITIES OF LARGE TRANSPORT CONFIGURATIONS. TESTS WILL BE CARRIED OUT TO INVESTIGATE THE PILOT CONTROL AND INSTRUMENT MONITORING PROBLEMS AS AFFECTED BY VIBRATION. STUDIES WILL BE CARRIED OUT ON THE AMES VERTICAL ACCELERATION AND ROLL DEVICE TO DETERMINE THE EFFECTS OF VEHICLE DYNAMICS OF PILOT CONTROL PERFORMANCE FOR SELECTED LEVELS AND FREQUENCIES OF VERTICAL ACCELERATION. SUBSEQUENT TESTS, BOTH IN-HOUSE AND BY CONTRACT, WILL EXTEND THIS EFFORT TO THE LATERAL VIBRATION AND TO MORE SOPHISTICATED FLIGHT TASKS. IN ADDITION, TESTS WILL BE CONDUCTED SIMULTANEOUSLY ON VIBRATION ISOLATION SEAT AND MODIFIED DISPLAY/CONTROL SYSTEMS.

RTOP NO. 126-62-10 TITLE: HANDLING QUALITIES

ORGANIZATION: HEADQUARTERS

MONITOR: WASICKO, R. J. TEL. 202-962-4601

TECHNICAL SUMMARY

UNDER CONTRACT, RESEARCH IS BEING PERFORMED TO DETERMINE THE EFFECTS OF AND THE IMPORTANT PARAMETERS RELATED TO ATMOSPHERIC TURBULENCE ON PILOT CONTROLLABILITY AND HANDLING QUALITIES. THIS WORK INVOLVES ANALYSES, COMPUTER STUDIES AND IN-FLIGHT EVALUATIONS WITH A VARIABLE STABILITY AIRCRAFT. ALSO UNDER CONTRACT ARE TWO RESEARCH PROGRAMS TO DEVELOP IMPROVED PROCEDURES FOR ASSESSING TURBULENCE-PENETRATION PERFORMANCE AND AUTOPILOT/FLIGHT DIRECTOR DESIGN CRITERIA FOR TURBULENCE SUPPRESSION. THESE EFFORTS ARE PRIMARILY ANALYTICAL WITH SOME LIMITED GROUND-BASED SIMULATION. THESE PROGRAMS ARE BEING PERFORMED BECAUSE ATMOSPHERIC TURBULENCE IS KNOWN TO HAVE A DETRIMENTAL EFFECT ON PATH PERFORMANCE AND HANDLING QUALITIES AS WELL AS CONTRIBUTING TO LOSS OF CONTROL SITUATIONS. EXISTING QUANTITATIVE DATA ON THE RELATIONSHIPS BETWEEN TURBULENCE PARAMETERS, HANDLING QUALITIES AND OPERATIONAL PROCEDURES ARE INADEQUATE TO PERMIT PROPER CONSIDERATION OF TURBULENCE IN FUTURE AIRCRAFT DESIGN.

RTOP NO. 126-62-11 TITLE: DYNAMIC STABILITY AND CONTROL
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: REDISS, H. A. TEL. 805-258-3311
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS EFFORT IS TO ADVANCE THE FUNDAMENTAL KNOWLEDGE OF FLIGHT DYNAMICS AND TO EXPLOIT THIS KNOWLEDGE TO DEVELOP METHODS FOR OPTIMIZING SPECIFIC FLIGHT CONTROL OR PERFORMANCE GOALS AND TO IMPROVE FLIGHT TEST ANALYSIS TECHNIQUES. ANALYTICAL STUDIES, COMPUTER SIMULATIONS AND FLIGHT TEST INVESTIGATIONS ARE BEING PERFORMED BOTH IN-HOUSE AND UNDER RESEARCH CONTRACTS AND GRANTS TO MEET THIS OBJECTIVE.

RTOP NO. 126-62-11 TITLE: DYNAMIC STABILITY AND CONTROL
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE BROAD OBJECTIVE IS TO EXPAND FUNDAMENTAL KNOWLEDGE OF THE DYNAMIC STABILITY AND CONTROL CHARACTERISTICS OF AIRCRAFT, INCLUDING SPINNING, AND TO DETERMINE THE EFFECTS OF THESE CHARACTERISTICS IN TERMS OF PILOTING THE AIRCRAFT. SPECIFIC OBJECTIVES ARE TO INVESTIGATE THE FUNDAMENTAL NATURE OF THE SPIN INCLUDING THE DEVELOPMENT OF METHODS FOR THEORETICAL ANALYSIS, AND TO INVESTIGATE THE PROBLEMS PRODUCED BY OPERATION OUTSIDE THE NORMAL FLIGHT ENVELOPE, BY VARIATIONS IN APPROACH TECHNIQUES, AND BY DEVIATIONS FROM CONFIGURATION NORMS. THE METHODS OF APPROACH INCLUDE WIND TUNNEL FORCE TESTS, THEORETICAL ANALYSIS, PILOTED SIMULATOR TESTS, DYNAMIC MODEL TESTS, AND FLIGHT TESTS OF FULL-SCALE AIRCRAFT.

RTOP NO. 126-63-10 TITLE: AIRCRAFT OPERATIONAL SUPPORT
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

MAINTENANCE AND OPERATION OF AIRCRAFT FOR RESEARCH AND DEVELOPMENT, PROFICIENCY, CHASE, AND GENERAL RESEARCH AND DEVELOPMENT SUPPORT. THIS ALSO INCLUDES THE ACQUISITION OF A NORTH AMERICAN SABRELINER. THIS AIRPLANE IS THE COMMERCIAL VERSION OF THE T-39. ALTHOUGH THERE ARE PROBABLY MANY INTERCHANGEABLE PARTS, THE SABRELINER IS A STRUCTURALLY STRONGER AIRPLANE THAN THE T-39. FOR INSTANCE, THE FUSELAGE SKIN IS 0.050 VERSUS 0.030 FOR THE SABRELINER AND T-39, RESPECTIVELY. MAXIMUM FLAP SPEED IS 30 KNOTS HIGHER AND LIMITING MACH NUMBER IS 0.82 VERSUS 0.77. THIS AIRPLANE WILL BE USED FOR ATMOSPHERIC STUDIES SUCH AS HIGH ALTITUDE TRAILING VORTICES, LASER DETECTION OF TURBULENCE, AEROSOL COUNT, ETC., THAT THE T-33 WAS ABLE TO ACCOMPLISH ONLY PARTIALLY OR NOT AT ALL DUE TO ITS LIMITED PERFORMANCE AND POOR PRESSURE-TEMPERATURE ENVIRONMENT FOR SENSITIVE INSTRUMENTATION. THE SABRELINER WILL ALSO BE A MUCH BETTER VEHICLE FOR TERMINAL AREA DISPLAYS THAN THE AERO COMMANDER CURRENTLY BEING USED IN A LIMITED EVALUATION.

RTOP NO. 126-63-10 TITLE: AIRCRAFT OPERATIONAL SUPPORT
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: BEHEIM, M. TEL. 216-433-4000
TECHNICAL SUMMARY

LEWIS-BASED AIRCRAFT, INCLUDING RESEARCH AIRPLANES, TRANSPORTS, AND CHASE PLANES MUST BE SERVICED, MODIFIED, AND MAINTAINED IN FLIGHTWORTHY STATUS. MANPOWER AND FUNDING ESTIMATED FOR THIS PURPOSE ARE ALLOCATED IN THIS RTOP.

RTOP NO. 126-63-10 TITLE: AIRCRAFT OPERATIONAL SUPPORT
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

RESEARCH FLIGHT INVESTIGATIONS ARE CONDUCTED USING THE FOLLOWING TEST AIRCRAFT: CONVAIR 990 CONVAIR 340 LEAR JET F-100C T-38A PROVISION MUST BE MADE FOR MAINTENANCE AND OPERATING COSTS FOR THESE AIRCRAFT. PURCHASE WILL BE MADE OF T-38A AIRCRAFT FOR RESEARCH SUPPORT USE.

RTOP NO. 126-63-10 TITLE: AIRCRAFT OPERATIONAL SUPPORT
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: WHITESIDE, W. W. TEL. 805-258-3311
TECHNICAL SUMMARY

MAINTENANCE AND OPERATION ARE PROVIDED FOR ALL AIRCRAFT SYSTEMS INCLUDING INSTRUMENTATION, FOR THE FOLLOWING AIRCRAFT: #801 AEROCOMMANDER, #809 B-57B, #811 F-104N, #812 F-104N, #812 JETSTAR, #815 T-33A, #817 C-47H, #818 F-104A, #820 F-104A, #57-1303 F-104B, #57-5921 U-3A, AND #145546 F-8C. THESE EFFORTS ARE ACCOMPLISHED MAINLY IN-HOUSE, WITH ASSISTANCE AS REQUIRED BY SUPPORT PROVIDED BY THE MILITARY SERVICES AND BY CONTRACTORS. THIS EFFORT IS REQUIRED TO PROVIDE FOR ADEQUATE PILOT PROFICIENCY, CHASE AIRCRAFT SUPPORT, R AND D SUPPORT OF RESEARCH INVESTIGATIONS, AND GENERAL AIRCRAFT OPERATIONAL AND INSTRUMENTATION SUPPORT TO PERMIT CONTINUATION OF A BROAD-BASED AIRCRAFT AND SPACE TECHNOLOGY PROGRAM.

RTOP NO. 126-63-11 TITLE: TITLE SUPPORT OF OTHER GOVERNMENT AGENCY
AND INDUSTRY AERODYNAMIC TESTING
REQUIREMENTS

ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

WITH DUE CONSIDERATION OF AVAILABLE MANPOWER, FUNDS, AND OBLIGATIONS TOWARDS NASA RESEARCH AND PROJECTS, AMES SUPPORTS OTHER GOVERNMENTAL AGENCY AND INDUSTRY PROGRAMS IN AERONAUTICS. THE SUPPORT CONSISTS OF CONSULTATION, ASSIGNMENT OF PERSONNEL TO ADVISORY COMMITTEES OR BOARDS, AND THE CONDUCT OF TESTS IN WIND TUNNELS, OR OTHER FACILITIES. THE MAJOR PORTION OF THIS EFFORT IS IN SUPPORT OF THE DEPARTMENT OF DEFENSE ALTHOUGH THE ADVENT OF THE SUPERSONIC

TRANSPORT HAS INCREASED THE ALLOTMENT OF TIME TO OTHER GOVERNMENTAL AGENCIES (IN PARTICULAR, THE DEPARTMENT OF TRANSPORTATION) CONSIDERABLY. IN GENERAL, MANPOWER AND TEST TIME IS ALLOCATED ONLY WHEN THE NEED FOR SPECIAL UNIQUE CAPABILITIES OF THE PERSONNEL OR THE EQUIPMENT IS EVIDENT, AND THE REQUEST IS IN THE NATIONAL INTEREST.

RTOP NO. 126-63-11 TITLE: SUPPORT OF OTHER GOVERNMENT AGENCY AND
INDUSTRY TESTING REQUIREMENTS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THE NASA HAS A UNIQUE AERODYNAMIC TEST CAPABILITY REPRESENTED AT THE LANGLEY RESEARCH CENTER BY A NUMBER OF LARGER WIND TUNNELS AND UNIQUE STRUCTURAL AND PROPULSIVE TEST APPARATUS. THESE FACILITIES ARE USED TO PROVIDE WIND TUNNEL TEST SUPPORT AND RELATED AERODYNAMIC PROPULSIVE AND STRUCTURAL FACILITY TECHNICAL SUPPORT OF OTHER GOVERNMENT AGENCIES INCLUDING BOTH GOVERNMENT SPONSORED AND PRIVATE R AND D ON AERONAUTICAL VEHICLE SYSTEMS. INVESTIGATIONS ARE CONDUCTED AS REQUIRED AT THE REQUEST OF THE COGNIZANT AGENCY; FOR EXAMPLE FOR THE DOD IN THE DEVELOPMENT OF NEW MILITARY AIRCRAFT AND MISSILE SYSTEMS; FOR DOT IN SUPPORT OF THE SST PROGRAM, OR FOR DOT IN R AND D ON HIGH-SPEED GROUND TRANSPORTATION.

RTOP NO. 126-63-11 TITLE: SUPPORT OF OTHER ORGANIZATIONS

ORGANIZATION: NASA HEADQUARTERS

MONITOR: MARTIN, J. A. TEL. 202-962-0174

TECHNICAL SUMMARY

OCCASIONALLY THE NEED ARISES TO ASSIST OTHER ORGANIZATIONS, IE. AGARD AND THE COMBUSTION INSTITUTE, BY SUPPORTING THEIR SYMPOSIA OR THE PUBLICATION OF THEIR PROCEEDINGS. THIS SUPPORT IS MORE A FUNCTION OF HEADQUARTERS THAN A PARTICULAR FIELD CENTER.

RTOP NO. 126-63-12 TITLE: UPDATING AND SUPPORT OF TEST
FACILITIES--HEAT FACILITY

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: SEFIC, W. J. TEL. 805-258-3311

TECHNICAL SUMMARY

AS PRESENT AND FUTURE VEHICLES REACH HIGHER-STRUCTURAL TEMPERATURES, THE RELIABILITY OF PRESENT METHODS FOR DETERMINING THE STRUCTURAL RESPONSES WILL DECREASE; AND NEW AND DIFFERENT CONFIGURATIONS AND MATERIALS WILL PRESENT MORE DIFFICULT PROBLEMS OF LOAD AND STRESS DETERMINATION. THE HIGH TEMPERATURE LOADS CALIBRATION LABORATORY IS BEING USED FOR STRUCTURAL TESTS LOADS CALIBRATIONS, AND DEFLECTION MEASUREMENTS OF PRESENT AND FUTURE HIGHPERFORMANCE VEHICLES. THE OBJECTIVES OF THIS TASK ARE TO PROVIDE THE PROFESSIONAL AND TECHNICAL SUPPORT NECESSARY FOR THE OPERATION OF THE FACILITY AND ITS SUPPORT EQUIPMENT. SUPPORT FOR THE LABORATORY INVOLVES PLANNING AND SCHEDULING OF TESTS, DESIGN AND FABRICATION OF

TEST FIXTURES AND JIGS, INSTALLATION AND CHECKOUT OF RADIANT HEATERS, LOADING AND INSTRUMENTATION EQUIPMENT, OPERATION OF TEST AND DATA ACQUISITION EQUIPMENT, AND ACQUISITION, REDUCTION, AND ANALYSIS OF MECHANICAL AND THERMAL-LOADS DATA. PROCUREMENT OF NECESSARY MATERIALS AND EQUIPMENT IS ALSO REQUIRED AND INVOLVES SPECIFICATION PREPARATION, PROPOSAL EVALUATION, AND TESTING FOR VERIFICATION OF SPECIFICATIONS.

RTOP NO. 126-63-12 TITLE: UPDATING AND SUPPORT OF AERODYNAMIC FACILITIES

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, L. TEL. 415-961-1111

TECHNICAL SUMMARY

IN CONDUCTING AERONAUTICAL RESEARCH IN WIND TUNNELS IT IS NECESSARY TO CARRY ON A CONTINUOUS REVIEW OF THE EQUIPMENT AND INSTRUMENTATION EMPLOYED, AND ALSO THE TESTING TECHNIQUES, IN ORDER TO MAINTAIN AND REPLACE ITEMS, AND IN ORDER TO INCORPORATE NEW EQUIPMENT AND CONCEPTS INTO THE OPERATION WHENEVER THEY PROVE DESIRABLE. THE INCREASING DEMAND FOR WIND TUNNEL TEST TIME, PARTICULARLY IN THE TRANSONIC SPEED RANGE, OBLIGATES WIND TUNNEL OPERATORS TO MAKE MAXIMUM USE OF THE AVAILABLE TEST HOURS, RESULTING IN A CONSTANT SEARCH FOR APPARATUS OR METHODS THAT WILL PRODUCE MORE DATA PER TEST HOUR.

RTOP NO. 126-63-12 TITLE: UPDATING & SUPPORT OF TEST FACILITIES

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: LOGAN, O., JR. TEL. 216-433-4000

TECHNICAL SUMMARY

MODERNIZE AND REFINE PROPULSION TEST STANDS AND LABORATORIES, AND DEVELOP MORE EFFICIENT EXPERIMENTAL TECHNIQUES FOR ENGINE AND COMPONENT RESEARCH. FACILITY IMPROVEMENTS AND INSTRUMENTATION PROCEDURES TO EXTEND TEST CAPABILITIES OR REDUCE OPERATIONAL MANPOWER REQUIREMENTS. OVERHAUL AND UPGRADING OF OLDER ITEMS WHICH ARE STILL SERVICEABLE BUT INEFFICIENT BY PRESENT DAY STANDARDS.

RTOP NO. 126-63-12 TITLE: UPDATING AND SUPPORT OF FACILITIES

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

TO MAINTAIN THE CAPABILITIES AND OPERATIONAL EFFICIENCY OF EXISTING WIND TUNNEL AND STRUCTURAL TEST FACILITIES VITAL TO CONTINUING NASA AND GOVERNMENT-WIDE RESEARCH AND DEVELOPMENT NEEDS. UPDATE AUXILIARY EQUIPMENT AND INSTRUMENTATION AS REQUIRED TO INCREASE QUALITY AND SCOPE OF DATA OBTAINABLE. PROVIDE ADVANCED DATA ACQUISITION, REDUCTION, AND READOUT SYSTEMS. EQUIPMENT AND UPDATING INCLUDE: A. WALLOPS SUPPORT. B. REPLACEMENT HELIUM HEATER FOR HIGH REYNOLDS NUMBER HELIUM TUNNELS, MACH 10 AND 20 LEGS FOR \$650,000. IT WILL SUPPLY HIGH TEMPERATURE HELIUM TO THE MACH 10 AND

20 LEGS OF THE HIGH REYNOLDS NUMBER TUNNELS. IT WILL BE AN ELECTRICAL RESISTANCE STORAGE TYPE HEATER DESIGNED TO OPERATE AT A PRESSURE OF 6600 PSIA WITH A MAXIMUM OUTPUT TEMPERATURE OF 650 DEGREES F AND A MAXIMUM FLOW RATE OF 300 LB/SEC. IN OPERATION A LARGE MASS OF HIGH PRESSURE TUBING WILL BE HEATED TO A SUITABLE TEMPERATURE; TEMPERATURE CONTROL WILL BE ACHIEVED BY MIXING COLD HELIUM WITH HOT HELIUM UPSTREAM OF THE STAGNATION CHAMBER. EXISTING SUPPLY PIPING AND MIXING VALVES WILL BE AN INTEGRAL PART OF THE NEW HEATER DESIGN. AN EXISTING GAS HEATER ORIGINALLY SUPPLIED THE TUNNELS, HOWEVER, INTERNAL AND EXTERNAL CORROSION OF THE TUBING BUNDLE HAS RENDERED IT UNSAFE AND IT HAS BEEN REMOVED FROM THE SYSTEM. THE NEW HEATER WILL REPLACE THE OLD HEATER IN A LOCATION ADJACENT TO BUILDING 1247-H.

RTOP NO. 126-63-13 TITLE: UPGRADING AND SUPPORT OF SIMULATION FACILITIES

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, L. TEL. 415-961-1111

TECHNICAL SUMMARY

RESEARCH IS BEING CARRIED OUT TO DEVELOP ADVANCED HARDWARE AND SOFTWARE TECHNIQUES TO INCREASE THE NUMBER AND SCOPE OF CUES REQUIRED BY THE PILOT IN AN ADVANCED AIRCRAFT SIMULATION PROJECT. SOME OF THE INVESTIGATIONS ARE CONCERNED WITH THE SOFTWARE OF THE SIMULATION, INCLUDING A REFINEMENT OF MATHEMATICAL MODELS USED, THE DEVELOPMENT OF COMPUTER ANALYSIS AND PROGRAMMING TECHNIQUES TO ALLOW CONVENIENT DATA ACQUISITION AND MONITORING AND CONVENIENT PARAMETRIC VARIATION DURING TESTING, THE DEVELOPMENT OF OPERATIONAL TECHNIQUES FOR EFFICIENT CONDUCTING OF TESTING, AND THE OPTIMUM USE OF EXISTING MOTION AND OUT-THE-WINDOW VISUAL SYSTEM HARDWARE, INCLUDING WASHOUT, ANGLE OF VIEW, ETC. OTHER INVESTIGATIONS ARE CONCERNED PRINCIPALLY WITH HARDWARE, INCLUDING APPLICABLE USE OF SPECIAL-PURPOSE COMPUTERS, REQUIREMENT DETERMINATION MOTION GENERATORS AND SUPPRESSION OF THEIR EXTRANEIOUS CUES, INCREASED RESOLUTION AND FIELD-OF-VIEW OF OUT-THE-WINDOW VISUAL SYSTEMS, AND DEVELOPMENT OF SIMULATOR INSTRUMENTS. STUDIES WILL BE CARRIED OUT TO INVESTIGATE THE VARIOUS MODES OF FAILURE OF MAN-CARRYING FLIGHT SIMULATORS TO DETERMINE THE DEGREE OF CRITICALITY OF FAILURE MODES ON THE SAFETY OF THE SIMULATOR OCCUPANTS AND OPERATING CREW. THESE STUDIES ARE USED AS A BASE FOR DEVELOPING TESTING AND OPERATING PROCEDURES, AND FOR MANRATING A SIMULATOR FACILITY. THIS RTOP ALSO COVERS MODIFICATION AND MAINTENANCE OF FLIGHT SIMULATION FACILITIES.

RTOP NO. 126-63-13 TITLE: SIMULATORS

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: SMITH, J. P. TEL. 805-258-3311

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO PROVIDE AND OPERATE THE NECESSARY GROUND-BASED SIMULATION FACILITIES AND EQUIPMENT. THIS WORK WILL BE DONE IN SUPPORT OF FLIGHT DYNAMICS RESEARCH. THIS OBJECTIVE WILL BE ACCOMPLISHED BY THE ANALYSIS OF PROGRAM

REQUIREMENTS, AND THE DESIGN, DEVELOPMENT, CONSTRUCTION, MAINTENANCE AND REPAIR OF THE REQUIRED GROUND-BASED SIMULATION FACILITIES AND EQUIPMENT.

RTOP NO. 126-63-13 TITLE: SIMULATORS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

TO UPGRADE AND SUPPORT THE OPERATION OF SIMULATION FACILITIES USED IN FLIGHT DYNAMICS AND MANNED FLIGHT CONTROL AND GUIDANCE RESEARCH. ANALYZE, DESIGN, DEVELOP, CONSTRUCT, CHECKOUT, TEST, VALIDATE, MAINTAIN, REPAIR, CONVERT, AND INSPECT THE SIMULATION FACILITIES AT LRC USED IN AERODYNAMIC RESEARCH.

RTOP NO. 127-49-17 TITLE: CARDIOLOGY/HEMODYNAMICS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: HOFFLER, G. W. TEL. 713-483-5555
TECHNICAL SUMMARY

ORTHOSTATIC INTOLERANCE IS AN IMPORTANT ELEMENT OF CARDIOVASCULAR CONCERN FOR MANNED SPACE FLIGHT. PATHOGENESIS AND PHYSIOLOGIC MECHANISMS ARE NOT CLEARLY UNDERSTOOD. THESE SEVERAL STUDIES ARE LOOKING AT SOME OF THE MORE IMPORTANT ASPECTS CONTRIBUTORY TO ORTHOSTATISM - THROUGH EVALUATIONS OF CONDITIONS PRODUCING SIMILAR SYMPTOMS, BY DELINEATING THE ROLE OF BLOOD VOLUME, FLOW, AND DISTRIBUTION, AND FROM COMPOUNDING PHYSIOLOGIC STRESSES UPON THE CARDIOVASCULAR SYSTEM.

RTOP NO. 127-49-19 TITLE: CLINICAL PATHOLOGY
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: FISCHER, C. L. TEL. 713-483-5281
TECHNICAL SUMMARY

EXTENSIVE BIOCHEMICAL INVESTIGATIONS PERFORMED ON SELECTED GEMINI FLIGHTS AND CHAMBER STUDIES, AND IN SUPPORT OF APOLLO MISSIONS, INDICATE A DETRIMENTAL EFFECT OF OXYGEN ON THE FORMED ELEMENTS OF THE BLOOD AND ON HEMOSTATIC MECHANISMS. THE FOLLOWING RESEARCH PROGRAMS ARE BEING CONDUCTED TO ELUCIDATE THE MECHANISMS OF THIS TOXIC EFFECT OF HIGH OXYGEN PRESSURES AND TO ASSESS THE APPARENT MODERATING EFFECT OF DILUENT GASES. ASSESSMENT OF RED CELL PHYSIOLOGY AND STRUCTURE WITH REGARD TO THE TOXIC EFFECTS OF OXYGEN. MEASUREMENTS WILL INCLUDE EVALUATION OF RED CELL MEMBRANE STATES, ENZYME KINETICS, AND PHYSICAL-CHEMICAL CHARACTERISTICS OF THE RED CELL POPULATION. RBC AND PLASMA ALPHA TOCOPHEROL AND ITS OXIDATIVE PRODUCTS WILL BE MEASURED USING MASS SPECTROMETRY AND IR ANALYSIS. TECHNIQUES WILL BE DEVELOPED FOR CONTINUOUS AUTOMATIC MEASUREMENT OF INTRAVASCULAR RED CELL DESTRUCTION BY MONITORING ENDOGENOUS CO

EXHALATION IN THE BREATH OF ASTRONAUTS IN SPACE. TECHNIQUES ARE BEING DEVELOPED USING WHOLE BLOOD SINGLE RADIAL IMMUNO DIFFUSION, ELECTROIMMUNO DIFFUSION, AND ALLIED METHODOLOGIES TO ASSESS THE INFLIGHT CELLULOS AND HUMORAL REACTIONS IN MAN.

RTOP NO. 127-49-20 TITLE: BIOMEDICAL APPLICATIONS/BIOINSTRUMENTATION
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: POOL, S. L. TEL. 713-483-4121
TECHNICAL SUMMARY

NASA HAS DEVELOPED SEVERAL TECHNIQUES, SUBSYSTEMS, AND SYSTEMS FOR BIOMEDICAL MONITORING IN SUPPORT OF MANNED SPACE FLIGHTS. THE TECHNOLOGY DEVELOPED HAS BEEN SPECIFICALLY FOR THE SPACE FLIGHT ENVIRONMENT, BUT IN MANY CASES IS ALSO DIRECTLY APPLICABLE TO GROUND-BASED MEDICAL USE. THESE SYSTEMS WERE DEVELOPED FOR MERCURY, GEMINI, AND APOLLO; NASA BIOINSTRUMENTATION DEVELOPMENT IS CONTINUING FOR SKYLAB AND SPACE STATION WITH THE IMBLS PROJECT. THESE BIOMEDICAL SYSTEMS, WHICH HAVE BEEN AND ARE BEING DEVELOPED FOR FLIGHT, ARE SAFE, SUBJECT ACCEPTABLE, NON-INVASIVE, AND SMALL. THE POWER REQUIRED TO OPERATE THEM IS SMALL. THE BIOINSTRUMENTATION SYSTEMS WHICH HAVE BEEN APPLIED TO SPACE FLIGHT ARE VERY RELIABLE AND YIELD HIGH QUALITY DATA. THE OBJECTIVE OF THIS EFFORT IS TO EVALUATE NASA BIOINSTRUMENTATION SYSTEMS FOR APPLICATION TO CLINICAL AND RESEARCH MEDICINE. IN MANY CASES NASA BIOINSTRUMENTATION SYSTEMS HAVE FEATURES WHICH MAKE THEM HIGHLY USEFUL IN THE CLINICAL AND RESEARCH ENVIRONMENT.

RTOP NO. 127-49-20 TITLE: MEASUREMENT OF HUMAN STRESS AND
PERFORMANCE (FLIGHT BIOINSTRUMENTATION)
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: WINTER, W. R. TEL. 805-258-3311
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PLAN IS TO SPECIFICALLY MONITOR CREW MEMBERS FLYING THE YF-12 AIR FORCE AIRCRAFT BEING EXTENSIVELY BY THE FLIGHT RESEARCH CENTER. THESE CREW MEMBERS ARE BEING MONITORED FOR VARIOUS PHYSIOLOGICAL STRESSES ENCOUNTERED DURING TYPICAL YF-12 MISSIONS.

RTOP NO. 127-49-22 TITLE: MICROBIOLOGY
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: MCQUEEN, J. TEL.
TECHNICAL SUMMARY

THE BASIC PURPOSE OF THE 127-49 FUNDED EFFORTS IS TO STUDY THE MICROFLORAL ALTERATIONS CREATED WITHIN THE ISOLATED SPACECRAFT ENVIRONMENT AND THE RESPONSE OF THE VITAL HOST SYSTEMS TO THESE ALTERATIONS. DEFINITION OF DETRIMENTAL ALTERATIONS AND THEIR RESULTING AFFECT ON THE HOST WILL PROVIDE RESEARCH DATA WHICH WILL ENABLE PREVENTIVE MEASURES TO BE DEVELOPED. EXPOSURE AND TEST METHODS INCLUDE, ISOLATION, DIETS, ANTIBIOTIC TREATMENTS AND

CHALLENGES WITH INFECTIOUS AGENTS (AS SINGLE VARIABLES AND COMBINATIONS). THE GENERAL MICROBIOLOGICAL, PHYSIOLOGICAL AND IMMUNOLOGICAL RESPONSES ARE MEASURED. IN ADDITION, METHODS AND TECHNIQUES ARE BEING DEVELOPED TO ENABLE EARLY RECOGNITION OF AN INFECTIOUS DISEASE PROCESS, TO ENABLE SCREENING OF FOOD PRODUCTS FOR INFECTIOUS VIRAL AGENTS, AND IN GENERAL, TO ADVANCE THE STATE-OF-THE-ART OF MICROBIOLOGY TO MEET THE REQUIREMENTS THAT HAVE BEEN CREATED BY THE ADVANCE IN TECHNOLOGY OF OTHER AREAS OF SCIENCE.

RTOP NO. 127-49-25 TITLE: PSYCHOACOUSTIC ASPECTS OF AIRCRAFT NOISE
AND SONIC BOOM

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO FURTHER THE UNDERSTANDING OF PSYCHOLOGICAL AND PHYSIOLOGICAL EFFECTS OF NOISE, TO ESTABLISH TECHNIQUES FOR MEASURING SUBJECTIVE NOISE FACTORS, AND TO APPLY PSYCHOACOUSTIC INFORMATION TO MINIMIZE THE POTENTIAL ANNOYANCE OF NOISE ON MAN BY MODIFICATIONS OF THE NOISE CHARACTERISTICS. STUDIES WILL INCLUDE SUBJECTIVE NOISE COMPARISON TESTS, ABSOLUTE JUDGEMENT TESTS, SLEEP INTERFERENCE TESTS, AUDITORY AND NON-AUDITORY TESTS, STARTLE TESTS, TASK PERFORMANCE TESTS, AND ACOUSTIC-VIBRATION TESTS. THE TESTS WILL BE ACCOMPLISHED IN LABORATORIES AND UNDER REAL LIFE CONDITIONS OF EXPOSURE TO AIRCRAFT NOISE DURING FLIGHT. SPECIAL ATTENTION WILL BE DIRECTED TO BRIDGING THE GAP BETWEEN THE FLIGHT EXPOSURE SITUATION AND LABORATORY TESTS. THE TESTS WILL BE COMPLEMENTED BY SURVEY STUDIES (INVOLVING SOCIAL, ECONOMIC, AND ATTITUDINAL FACTORS) AND BY SPECIAL ANALYTICAL PROGRAMS. THE DATA OBTAINED WILL BE USED TO DEVELOP AN INFORMATION BASE HAVING APPLICATION TO ESTABLISHING INTERNATIONAL NOISE STANDARDS, TO PREDICTION OF PUBLIC REACTIONS TO FUTURE AIRCRAFT/AIRPORT OPERATIONS, AND TO THE EVALUATION OF AIRCRAFT NOISE REDUCTION APPROACHES.

RTOP NO. 127-49-30 TITLE: NUTRITION AND FOOD

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: SMITH, M. C. TEL. 713-483-5056

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO ACQUIRE INFORMATION IN THE AREAS OF NUTRITIONAL BIOCHEMISTRY AND FOOD SCIENCE ESSENTIAL TO THE DESIGN OF FOOD SYSTEMS FOR FUTURE SPACECRAFT. THE BIOCHEMICAL EFFORT WILL BE DIRECTED TOWARD A QUANTITATIVE DETERMINATION OF HUMAN REQUIREMENTS FOR ORGANIC FLAVOR COMPONENTS. NEW DEVELOPMENTS IN SYNTHETIC FLAVOR CHEMISTRY WILL BE ASSESSED FOR THEIR APPLICABILITY TO IMPROVING THE ACCEPTANCE OF FOOD SUBSYSTEM COMPONENTS. NATURAL FOODS WILL BE ANALYZED FOR FLAVOR COMPOSITION BY GAS CHROMATOGRAPHIC AND OTHER TECHNIQUES. SIMILAR STUDIES WILL BE CONDUCTED IN THE AREA OF VITAMIN METABOLISM. AN EVALUATION OF THE UTILITY OF SYNTHETIC HIGH ENERGY METABOLITES IN SPACECRAFT FOOD SYSTEMS WILL ALSO BE CARRIED OUT. THE FOOD SCIENCE EFFORT WILL BE DIRECTED TOWARD EXTENDING THE PROMISING DEVELOPMENTS IN INTERMEDIATE MOISTURE FOOD

TECHNOLOGY AND TOWARD GAINING AN UNDERSTANDING OF HEAT TRANSFER THROUGH FOOD IN ZERO-G.

RTOP NO. 127-49-32 TITLE: MUSCULOSKELETAL METABOLISM
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: RAMBAUT, P. C., DR. TEL. 713-483-5056
TECHNICAL SUMMARY

THE EFFECTS OF PROLONGED HABITATION OF EXTRATERRESTRIAL VEHICLES, SHELTERS, AND FACILITIES ON MUSCULOSKELETAL FUNCTION AND CHARACTERISTICS WILL BE DETERMINED. THESE EFFECTS WILL BE INVESTIGATED TO DETERMINE THE IMPACT ON THE PERFORMANCE AND HEALTH OF MAN IN HIS NOMINAL EARTH ENVIRONMENT, THE VARIOUS AEROSPACE ENVIRONMENTS, AND COMBINATIONS OF BOTH. DELETERIOUS EFFECTS SHALL BE IDENTIFIED AND METHODS OF CORRECTION THROUGH DIETARY AND ENVIRONMENTAL MANIPULATION SHALL BE DETERMINED IN SIMULATED AEROSPACE SITUATIONS. EQUIPMENT TO MONITOR MUSCULOSKELETAL STATUS AND DETECT TENDENCIES TOWARD METABOLIC IMBALANCE OF A DIETARY NATURE WILL BE DEVELOPED FOR INSTALLATION IN THE SPACECRAFT OR FACILITY.

RTOP NO. 127-49-33 TITLE: RADIOLOGICAL HEALTH
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: BARNES, C. M. TEL. 713-483-4251
TECHNICAL SUMMARY

THIS RESEARCH PROGRAM IS DESIGNED TO EXPLORE AND DEFINE THE POTENTIAL BIOLOGICAL HAZARDS OF THE SPACE RADIATION ENVIRONMENT TO MANNED SPACE MISSIONS. THE PHYSIOLOGIC AND PATHOLOGIC CHANGES IN MAN SUBJECTED TO LONG DURATION SPACE RADIATION IS CONSIDERED. THE APPROACH USED INCLUDES RETROSPECTIVE AND PROSPECTIVE STUDIES OF HUMAN RESPONSE TO RADIATION THERAPY AND ACCIDENTAL EXPOSURES TO VARIOUS RADIATION SOURCES. IN ADDITION, EXPERIMENTAL ANIMALS ARE UTILIZED IN STUDIES SPECIFICALLY DESIGNED TO INVESTIGATE SIMULATED SPACE RADIATION HAZARDS. RESULTS ARE EVALUATED AND COMPARED WITH KNOWN HUMAN RESPONSE TO RADIATION. KNOWLEDGE OF RESPONSES TO IRRADIATION UNDER BOTH CONTINUOUS AND INTERMITTENT EXPOSURES AND AT LOW DOSE RATES IS NEEDED. IN PARTICULAR, DOSE-RESPONSE THRESHOLDS FOR MAN MUST BE ACCURATELY DEFINED. THERE IS NOW INSUFFICIENT KNOWLEDGE CONCERNING THESE FACTORS TO PERMIT DEFINITION OF RELIABLE RADIATION DOSE RESPONSE CRITERIA APPROPRIATE FOR FUTURE SPACE PROGRAMS.

RTOP NO. 127-49-37 TITLE: AEROSPACE BIOMEDICAL STUDIES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-1111
TECHNICAL SUMMARY

MAJOR RESEARCH EMPHASIS IS PLACED ON THE ACQUISITION OF A MUCH NEEDED DATA BANK OF THE "NORMAL RANGE" OF PHYSIOLOGICAL LEVELS IN NORMAL HUMANS, AND OF QUANTITATIVE INFORMATION ON THE ADAPTIVE CHANGES OF HUMAN AND OTHER ANIMAL ORGANISMS TO SPACE ENVIRONMENTS, FLIGHT STRESSES AND DESYNCHRONIZATION OF INTERNAL REGULATORY

PROCESSES BY RAPID FLIGHT THROUGH SEVERAL TIME-ZONES. THE APPROACHES TAKEN TO ACQUIRE THIS NECESSARY RESEARCH DATA ARE BY SUBJECTING MAN AND ANIMALS TO VARIOUS EXPERIMENTAL SITUATIONS, E.G., ENERGY UTILIZATION AND CARDIOVASCULAR CHANGES - MEASURED UNDER ALTERED GRAVITY; STRESS INDEXES - BIOASSAY OF HORMONES IN BLOOD AND TISSUES AND THE DEVELOPMENT OF OTHER HORMONAL AND NON-HORMONAL STRESS INDEXES; PATHOLOGIC CHANGES - EFFECTS OF OXYGEN TOXICITY TO VARIOUS TISSUE; ADAPTATION TO FLIGHT STRESS AND TIME-ZONE CHANGES - BY ACTUAL FLIGHT AND SIMULATION OF LIGHT/DARK CYCLE CHANGES. TO ENABLE TO PREDICT THE BODY'S RESPONSE TO SUCH CHANGES IN THE ENVIRONMENT FOR LONGER PERIODS OF TIME THAN POSSIBLE IN THE LABORATORY, THIS INFORMATION SHOULD BE USED TO DEVELOP COMPUTER MODELLING OF THE VARIOUS BODY SYSTEMS.

RTOP NO. 127-49-38 TITLE: HUMAN RESEARCH AND PERFORMANCE
ORGANIZATION: NASA HQ.
MONITOR: JONES, W. L. TEL. 202-962-0016
TECHNICAL SUMMARY

TO PROVIDE FUNDING FOR PARTIAL SUPPORT OF ARMED FORCES - NATIONAL RESEARCH COUNCIL COMMITTEE ON VISION AND FOR THE NATIONAL ACADEMY OF SCIENCES COMMITTEES WHICH PROVIDE DIRECT ASSISTANCE IN THE EVALUATION OF PERTINENT RESEARCH ACTIVITIES SUCH AS DESYNCHRONOSIS, CARDIOVASCULAR, MICROBIOLOGY, RESPIRATION, HEARING, BIOACOUSTICS AND BIOMECHANICS AND TOXICOLOGY. IN ADDITION THIS RTOP WILL PROVIDE FUNDS FOR THE UPDATING THE BIOASTRONAUTICS DATA BOOK, NASA SP-3006, FOR EXPLORATORY STUDIES IN HUMAN FACTORS PROBLEMS IN THE OPERATION OF THE SPACE SHUTTLE AND OTHER RELATED FUNCTIONS OF A NON-RESEARCH NATURE WHICH WILL IDENTIFY POTENTIAL PROBLEM AREAS IN THE OVERALL BIOTECHNOLOGY AND HUMAN RESEARCH PROGRAM.

RTOP NO. 127-49-40 TITLE: PHYSIOLOGICAL PROBLEMS OF SPACE STATION LIVING
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-1111
TECHNICAL SUMMARY

MAJOR EMPHASIS IS BEING PLACED ON THE DEVELOPMENT OF A BIOMEDICAL RESEARCH PROGRAM DIRECTED TOWARD THE DETERMINATION OF HUMAN PHYSIOLOGIC RESPONSES TO THE ENVIRONMENTAL AND PHYSIOLOGIC STRESSES ASSOCIATED WITH EXTENDED SPACE STATION OPERATION. THIS PROGRAM IS BASED ON THE DEVELOPMENT AND REFINEMENT OF EXISTING METHODS OF QUANTITATING THE EFFECTS OF VARIOUS SPACE ENVIRONMENTS SUCH AS WEIGHTLESSNESS, RADIATION, AND NUTRITIONAL FACTORS ON BODY SYSTEMS. INSTRUMENTATION IS BEING DEVELOPED FOR MEASUREMENT OF PERTINENT PHYSIOLOGICAL PARAMETERS IN MAN. AREAS OF SPECIFIC INTEREST ARE: THE DETERMINATION OF AN ACCEPTABLE SPACE STATION OPERATING ENVIRONMENT, THE PHYSIOLOGICAL AND PSYCHOPHYSIOLOGICAL RESPONSES TO SPACE FLIGHT STRESSES, THE DETERMINATION OF SPACE RADIATION EFFECTS AND ASSESSMENT OF THE HAZARDS OF TYPICAL SPACE STATION OPERATIONS AND NEED FOR PROTECTION, THE EFFECTS OF THE SPACE STATION ENVIRONMENT ON ESSENTIAL METABOLIC PROCESSES, THE DETECTION

AND CONTROL OF POTENTIAL MICROBIOLOGICAL PROBLEMS PERTINENT TO CLOSED OR SEMI-CLOSED ECOLOGICAL SYSTEMS, THE ASSESSMENT OF CARDIOVASCULAR ADAPTATION TO ACCELERATION AND WEIGHTLESSNESS AND THE FACTORS NEEDED TO INSURE ASTRONAUT'S MEDICAL WELL-BEING DURING EXTENDED SPACE FLIGHT. THE OVERALL APPROACH IN ACCOMPLISHING THESE OBJECTIVES WILL BE TO CONTINUE THOSE IN-HOUSE EFFORTS DIRECTED AT IDENTIFYING THE BASIC PROBLEMS AND SOLUTIONS. CONTRACTUAL EFFORTS WILL BE INSTITUTED FOR TOTAL SYSTEMS INTEGRATION AND DEVELOPMENT.

RTOP NO. 127-49-41 TITLE: HUMAN RESPONSE TO SPACE ENVIRONMENTS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THE HAZARDOUS EFFECTS OF EXPOSURE OF MAN TO THE ENVIRONMENT OF RADIATION, ZERO "G," AND NOISE TO BE ENCOUNTERED IN A SPACE STATION MISSION PLACES CONSTRAINTS ON BOTH MISSION AND SPACECRAFT DESIGNS. THIS RESULTS FROM THE FACT THAT THE STATE OF KNOWLEDGE OF MAN'S RESPONSE TO THESE ENVIRONMENTAL FACTORS IS LIMITED AND INADEQUATE FOR THE VARIETY OF CONDITIONS THAT EXIST FOR SUCH MISSIONS. IT IS, THEREFORE, VERY DIFFICULT AT THIS TIME TO ESTABLISH MEANINGFUL TOLERANCE LEVELS THAT CAN BE USED AS DESIGN CRITERIA THAT ACCOUNT FOR PHYSICAL INCOMPACITATION RESULTING FROM ACUTE EMERGENCY EXPOSURES, AS WELL AS LONG TERM, LOW LEVEL EXPOSURES THAT PRODUCE POSSIBLE REDUCED PERFORMANCE OF THE ASTRONAUT. DELAYED RESPONSES THAT MAY RESULT IN EVENTUAL IMPAIRMENT OF HEARING, SIGHT, AND POTENTIAL CARCINOGENIC EFFECTS, HAVE SERIOUS IMPLICATIONS ON CREW SELECTION. RESEARCH IS PLANNED IN SPECIFIC PROBLEM AREAS AND INCLUDES RADIATION DAMAGE TO THE LENS OF THE EYE, THE SKIN, AND OTHER BODY ORGANS. HERE EXPERIMENTS AND THEORETICAL WORK WILL CONSIDER SUCH VARIABLES AS RADIATION TYPE (X-RAY, PROTON, ELECTRON, AND OTHER HEAVILY IONIZING PARTICLES) AND ENERGY, ORGAN BEING IRRADIATED, TYPE OF DAMAGE, CAPACITY OF ORGAN OR TISSUE TO SELF REPAIR, AND DETERMINATION OF DOSE RECEIVED. REDUCED GRAVITY EFFECTS ON THE HUMAN PHYSIOLOGICAL SYSTEM ARE TO BE STUDIED TO ASCERTAIN MAN'S CAPABILITY TO PERFORM IN SPACE STATION ENVIRONMENT. EXPERIMENTS ARE ALSO BEING CONDUCTED TO DETERMINE THE DAMAGE TO THE EAR FROM A SIMULATED NOISE ENVIRONMENT THAT REPRESENTS LONG TIME EXPOSURES.

RTOP NO. 127-51-12 TITLE: AIRCREW PERFORMANCE AND STRESS APPRAISAL

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: KLEIN, H. P. TEL. 415-961-2735

TECHNICAL SUMMARY

RESEARCH IS BEING CONDUCTED TO IDENTIFY, DEFINE, AND SOLVE COMMERCIAL AVIATION PROBLEMS HAVING TO DO WITH THE FUNCTIONING OF THE HUMAN OPERATOR IN MODERN HIGH SPEED, HIGH ALTITUDE, PASSENGER AIRCRAFT SYSTEMS. ONE SPECIFIC GOAL OF THIS EFFORT IS TO MAKE THE NECESSARY TECHNICAL CONTRIBUTIONS TO THE ATTAINMENT OF SAFE, RELIABLE, AND COMFORTABLE ZERO VISIBILITY TERMINAL OPERATIONS. APPROPRIATE AREAS OF STUDY INCLUDE THE FOLLOWING: PILOT INFORMATION ACQUISITION AND DECISION MAKING; OPTIMUM CREW SIZE AND FUNCTION

ALLOCATION; WORK LOAD AND TASK INDUCED STRESS; PILOT VISUAL PERFORMANCE IN USING HEAD-UP DISPLAYS, DURING LOW VISIBILITY LANDINGS, AND IN COLLISION AVOIDANCE, FATIGUE AND VIGILANCE; VERTIGO AND DISORIENTATION; AND PILOT ACCEPTANCE AND OPINION OF NEW EQUIPMENTS AND TECHNIQUES. IN ADDITION TO THE IDENTIFICATION OF AND RESEARCH ON OPERATING PROBLEMS INVOLVING HUMAN READINESS AND CAPACITY TO PERFORM, ATTEMPTS WILL BE MADE TO DEVELOP AND APPLY NEW TECHNIQUES OF BIOTECHNOLOGICAL ANALYSIS, EVALUATION AND PREDICTION OF HUMAN RESPONSE. IN SUMMARY, THIS EFFORT IS THREEFOLD: (1) IDENTIFY HUMAN FACTORS PROBLEMS IN COMMERCIAL AVIATION, (2) ATTEMPT SOLUTIONS THROUGH WHOLE AND PART TASK SIMULATIONS, AND (3) BROADEN THE TECHNOLOGICAL CAPACITY FOR SO DOING. THE GOALS ARE INCREASED SAFETY, RELIABILITY, EFFICIENCY, ECONOMY, COMFORT, AND JOB SATISFACTION IN COMMERCIAL AVIATION OPERATIONS.

RTOP NO. 127-51-15 TITLE: CREW PERFORMANCE AND DATA HANDLING
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: WINTER, W. R. TEL. 805-258-3311
TECHNICAL SUMMARY

THIS WORK INVESTIGATES THE RELATIONSHIP BETWEEN CREW PERFORMANCE, AS INDICATED BY PHYSIOLOGICAL RESPONSES, TO THE FLIGHT ENVIRONMENT AND INCLUDES THE DATA HANDLING AND REDUCTION TECHNIQUES NECESSARY TO CORRELATE THESE DATA WITH BASELINE PHYSIOLOGICAL INFORMATION. THE MAJOR EFFORT DURING FISCAL 71 WILL BE TO DEVELOP AND FABRICATE PHYSIOLOGICAL, ENVIRONMENTAL AND AIRCRAFT PERFORMANCE PARAMETER MONITORING EQUIPMENT FOR USE IN MONITORING THE CREWS OF A LARGE COMMERCIAL AIRLINER.

RTOP NO. 127-51-17 TITLE: (AERONAUTICAL) CREW AND GROUND SUPPORT
CREW PERFORMANCE AND STRESS APPRAISAL
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-3285
TECHNICAL SUMMARY

(1) DETERMINE AND EVALUATE MAN-MACHINE COMMUNICATION AND INFORMATION PROCESSING SYSTEMS. (2) IDENTIFY HUMAN FACTORS ASSOCIATED WITH AIR TRAFFIC CONTROL (ATC), ANALYZE THE MAN-MACHINE RELATIONSHIP AND HUMAN PERFORMANCE TECHNIQUE IN ATC, AND RECOMMEND RESEARCH THAT WOULD IMPROVE THE PRESENT AND PROJECTED ATC SYSTEM. (3) PRODUCE AN ANALYTICAL MEANS OF DERIVING PROPER AIR COMBAT TACTICS FOR COMBINATIONS OF AIRCRAFT TO REDUCE PILOT TRAINING TIME ON THE DIFFERENTIAL MANEUVERING SIMULATOR TO PRODUCE A STANDARD OPPONENT IN THIS SIMULATOR. (4) ESTABLISH RIDE COMFORT CRITERIA AND DEVELOP MEANS FOR MEETING THESE CRITERIA THROUGH INCORPORATION OF CONTROL DEVICES APPLICABLE TO A VARIETY OF HIGH SPEED TRANSPORTATION MODES. (1, 2, 3) CONTINUE TO STUDY BASIC HUMAN FACTORS AND APPLY RESULTS TO CURRENT PROBLEMS, SUCH AS ATC AND AERIAL COMBAT. (4) SYSTEMATICALLY ACQUIRE AND ANALYZE VEHICLE RESPONSE DATA AND SUBJECTIVE IMPRESSION OF RIDE QUALITY WITH FIELD MEASUREMENTS. INVESTIGATE IN LABORATORY TESTS RIDE COMFORT CRITERIA. ESTABLISH PERFORMANCE SPECIFICATIONS TO IMPROVE RIDE QUALITY.

RTOP NO. 127-51-28 TITLE: APPROACH AND LANDING AND FLIGHT
VISIBILITY ENVELOPES FOR SPACE SHUTTLE

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: CARPENTER, L. R. TEL. 805-258-3311

TECHNICAL SUMMARY

COCKPIT VISIBILITY EXPERIMENTS ARE REQUIRED INVOLVING LABORATORY AND ACTUAL FLIGHT TEST. THESE STUDIES ARE SPECIFICALLY AIMED AT LIFTING BODIES AND OTHER SHUTTLECRAFT CONFIGURATION REQUIREMENTS. THE SUBJECTS FOR THESE STUDIES SHALL BE TEST PILOTS WITH X-15 AND LIFTING BODY FLYING EXPERIENCE. EXPERIENCE TO DATE INDICATES THAT FAST APPROACHES IN LIFTING BODIES CAUSE SIDE VISION BLURRING AND THE LOW HEAD HEIGHTS RELATIVE TO STRUCTURE HAMPERS FORWARD VISION. FURTHER STUDY IS NEEDED TO DETERMINE THE DESIRABILITY AND MINIMUM REQUIREMENTS FOR PERIPHERAL AND DIRECT VISUAL INPUTS FOR THE TERMINAL OPERATIONAL PHASE. FLIGHT RESEARCH CENTER TEST PILOTS SHALL FLY SHUTTLECRAFT TERMINAL APPROACHES AND PERFORM LANDINGS WITH APPROACH ANGLES AND VELOCITIES AS VARIABLES. HIGH PERFORMANCE AIRCRAFT WITH VARIABLE CANOPY VISIBILITY SHALL BE UTILIZED FOR THIS PROGRAM.

RTOP NO. 127-51-30 TITLE: MANNED SPACE SHUTTLE: PILOT-SYSTEM
INTERFACE AND PILOT GUIDANCE AND CONTROL
PROCEDURES IN TERMINAL FLIGHT

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: KLEIN, H. P. TEL. 415-961-1111

TECHNICAL SUMMARY

THE PILOTS ROLE IN MONITORING AN AUTOMATIC GUIDANCE AND CONTROL SYSTEM AND PROVIDING MANUAL BACKUP DURING THE TERMINAL AREA APPROACH AND LANDING WILL BE STUDIED WITH THE GOAL OF OPTIMIZING THE MANNED SYSTEM FOR SAFETY AND RELIABILITY. A SYSTEMS ANALYSIS STUDY WILL BE PERFORMED TO DEVELOP A SYSTEMS MODEL OF THE LANDING PHASE FOR THE VEHICLE. THE MODEL WILL INCLUDE SYSTEM ELEMENTS, COMMAND INPUTS, DISTURBANCES, AND THEIR INTERACTIONS IN AN ANALYTICAL FRAMEWORK SO THAT THE RELATIVE EFFECTS OF CHANGES IN THE VARIOUS SYSTEM ELEMENTS ON PRECISION OF CONTROL, PILOT/CO-PILOT WORKLOADS AND AVAILABLE MARGINS OF SAFETY THROUGHOUT THE TERMINAL OPERATIONS ENVELOPE CAN BE ESTIMATED. CONCURRENT WITH THE SYSTEMS STUDY, PILOTED SIMULATOR STUDIES OF TERMINAL AREA OPERATIONS WILL BE MADE UTILIZING VARIOUS DISPLAY CONCEPTS AND CONFIGURATIONS. THE RESULTS OF THE SYSTEMS ANALYSIS STUDY AND THE SIMULATOR DISPLAY RESEARCH WILL BE COMBINED TO PROVIDE PILOT PROCEDURES DURING THE TERMINAL AREA PHASE OF THE MISSION.

RTOP NO. 127-51-30 TITLE: TELEOPERATOR TECHNOLOGY AND SYSTEM
DEVELOPMENT

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

THIS RTOP SET FORTH A NUMBER OF PLANNED STUDY AND DESIGN EFFORTS WHICH PROVIDE A PROGRAM OF ACTIVITIES LEADING TOWARD THE DEVELOPMENT OF SELECTED SUBSYSTEMS, COMPONENTS, AND SYSTEMS APPLICABLE TO THE

AREA OF TELEOPERATORS AND THEIR USE IN SPACE OPERATIONS, I.E., SPACE SHUTTLE, SPACE STATION, SPACE TUG. TELEOPERATORS ARE AN OUTGROWTH OF REMOTE MANIPULATOR TECHNOLOGY AND REPRESENT A CLASS OF MACHINES THAT HAVE GREAT POTENTIAL TO AID AND ENHANCE THE CAPABILITY OF MAN IN SPACE OPERATIONS. TELEOPERATOR DEVELOPMENT WILL BE GREATLY SUPPORTED BY THE STATE OF THE ART OF MANIPULATOR TECHNOLOGY. THE OBJECTIVE OF THIS EFFORT IS TO EXPLORE AND DEVELOP THE NECESSARY TECHNOLOGY TO DESIGN, DEVELOP, AND EVALUATE AN ENGINEERING MODEL OR PROTOTYPE OF A TELEOPERATOR. EXTRAVEHICULAR TASKS OF VARIOUS KINDS REQUIRE THAT TELEOPERATOR TECHNOLOGY BE DEVELOPED NOW IN ORDER TO SUPPORT PLANNED OPERATIONAL SCHEDULES. FOR EXAMPLE, THE ISOTOPE BRAYTON POWER CONVERSION SYSTEM PROPOSED FOR THE SPACE STATION WILL REQUIRE A TELEOPERATOR SYSTEM FOR RECOVERY AND REPLACEMENT OF THE FUEL ELEMENT, AND CARGO HANDLING BY THE SHUTTLE. OBJECTIVES WILL BE ACCOMPLISHED BY IN-HOUSE AND CONTRACTED STUDIES, DESIGN AND DEVELOPMENT, WITH COMPLETE SIMULATION AND EVALUATION.

RTOP NO. 127-51-31 TITLE: MANNED SPACE SHUTTLE (CATEGORY II)
MAN-MACHINE INTEGRATION STUDIES (CREW AND
CARGO TRANSFER, DOCKING, AND LAUNCH ABORT)

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THE PRIMARY OBJECTIVES OF THESE ACTIVITIES ARE TO DEVELOP AND EVALUATE CONCEPTS AND TECHNIQUES FOR SOLVING SHUTTLE PROBLEMS IN THE AREA OF CREW AND CARGO TRANSFER, DOCKING AND TRANSFER OF CARGO MODULE, LAUNCH ABORT, AND EXTRAVEHICULAR ACTIVITIES. IT IS ALSO NECESSARY TO DETERMINE THE ASTRONAUT'S ABILITY TO PERFORM THESE VARIOUS FUNCTIONS; THEREFORE, WORKLOADS AND TIMELINES WILL BE INVESTIGATED. THIS INFORMATION WILL BE USED IN MANNED SPACE SHUTTLE DESIGN STUDIES FOR ACTUAL DESIGN OF OPERATIONAL HARDWARE.

RTOP NO. 127-51-32 TITLE: SPACE SHUTTLE CREW SYSTEMS INTERFACE

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

THE WORK TO BE ACCOMPLISHED THROUGH THIS RTOP LIES IN TWO AREAS:

- 1) DEVELOPMENT OF CREW WORKLOAD CRITERIA FOR SYSTEM MONITORING, AND
- 2) PERSONNEL/CARGO TRANSFER. TASK I. DEVELOPMENT OF CREW WORKLOAD FOR SYSTEM MONITORING CREW WORKLOAD CRITERIA IS REQUIRED TO DEFINE THE ROLE OF MAN AND DEVELOP DISPLAY AND PRIMARY AND BACK-UP MONITORING/CONTROL TECHNIQUES FOR THE SPACE SHUTTLE. UTILIZE EXISTING AND MODIFIED MSFC SIMULATION FACILITIES TO STUDY INFORMATION DISPLAY AND PROCESSING AND MANUAL CONTROL BACK-UP FOR CREW WORKLOAD STUDIES. DETERMINE CRITICAL TASKS REQUIRED OF PILOTS BY FUNCTIONS ANALYSES AND TASK EQUIPMENT ANALYSIS. DEVELOP PERFORMANCE GUIDELINES FOR PILOTS AND OPTIMUM CREW SIZE. THE EVOLUTION OF THIS WORK WILL FOLLOW VERY CLOSELY THE EARLY BREADBOARD DEVELOPMENT OF THE APOLLO TELESCOPE MOUNT CONTROLS AND DISPLAYS. TASK II. PERSONNEL/CARGO TRANSFER MAN/SYSTEM CRITERIA WILL BE EXPERIMENTALLY DEVELOPED WHICH

WILL DEFINE THE PERFORMANCE CAPABILITIES AND DESIGN REQUIREMENTS IMPOSED ON THE CARGO TRANSFER SYSTEM DESIGNERS TO ACCOMMODATE AND MAKE THE MOST EFFICIENT UTILIZATION OF THE CREWMAN. RESEARCH WORK IS REQUIRED TO DEFINE AND DEVELOP CREW AND CARGO TRANSFER TECHNIQUES AND CRITERIA FOR SYSTEM DESIGN AND OPERATION. SIMULATE PERSONNEL AND CARGO TRANSFER ACTIVITIES AND DEVELOP CONCEPTUAL EQUIPMENT AND PROCEDURES. EVALUATE THESE CONCEPTS IN NEUTRAL BUOYANCY AND OTHER ZERO GRAVITY SIMULATORS UTILIZING MOCKUPS OF CREW AND CARGO COMPARTMENTS. EVALUATE USE OF MANIPULATORS TO REDUCE EVA TASKS AND TO ASSIST CREW AND CARGO TRANSFER.

RTOP NO. 127-51-33 TITLE: SPACE SHUTTLE - TRADE-OFF IN TOTAL MISSION SIMULATION

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: SMITH, E. G. TEL. 713-483-2881

TECHNICAL SUMMARY

THE FEASIBILITY OF EARLY TOTAL SHUTTLE MISSION SIMULATION TO DESIGN AND DEVELOP IS TO BE DEMONSTRATED WITH A AVIONICS TEST BED, ALSO TO COLLECT ENGINEERING DATA ON AN ADVANCED INTEGRATED AVIONICS SYSTEM FOR DERIVATION OF CONCEPTS TO BE APPLIED FOR THE SPACE SHUTTLE. PRINCIPAL CONCEPTS TO BE EXPLORED ARE IN THE AREA OF THE MULTIPLEXED DATA BUSS, FLY-BY-WIRE CONTROL SYSTEM, DIGITAL AUTOPILOT, MULTIPURPOSE DISPLAYS, AUTOMATIC ONBOARD CHECKOUT AND REMOTE POWER SWITCHING.

RTOP NO. 127-51-34 TITLE: TRAINING SIMULATION RESEARCH FOR AERONAUTICS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

ESTABLISH A BASIC UNDERSTANDING OF THE RELATIONSHIP AND USE OF VISION, MOTION, NOISE AND OTHER FACTORS USED BY PILOTS AND CREW IN FLIGHT. ESTABLISH QUANTITATIVE VALUES OF THE REQUIRED SIMULATOR PARAMETERS SUCH AS RESOLUTION OF THE VISUAL SCENE, FIDELITY OF MOTION, WASHOUT, ETC., TO PERMIT A REDUCTION OF THE IN-FLIGHT TRAINING HOURS. ESTABLISH VALUES OF THESE PARAMETERS EXISTING IN SIMULATION TODAY AND MEANS FOR IMPROVING, IF REQUIRED AND IF POSSIBLE.

RTOP NO. 127-51-39 TITLE: MAN-MACHINE-ENVIRONMENT COMPLEX

ORGANIZATION: NASA HEADQUARTERS

MONITOR: DEUTSCH, S. TEL. 202-962-0018

TECHNICAL SUMMARY

RESEARCH IS UNDER WAY TO UNDERSTAND THE RELATIONSHIP OF MAN TO THE SPACE ENVIRONMENT AND THE EQUIPMENT REQUIRED FOR EFFECTIVE PERFORMANCE. HABITABILITY RESEARCH AND DEVELOPMENT IN PROGRESS CONCERNED WITH THE LIVING AREAS OF FUTURE SPACE STATIONS INCLUDE THE SLEEPING, EATING, PERSONAL HYGIENE, GARMENTS, AND OFF-DUTY ACTIVITIES OF SMALL CREWS. HABITABILITY DESIGN CRITERIA ARE UNDER DEVELOPMENT

AND WILL BE VALIDATED. THE PERFORMANCE OF INDIVIDUALS AND CREWS WORKING AND LIVING IN CONFINED AREAS ARE BEING MEASURED AND THEIR SOCIAL DYNAMICS BEING STUDIED TO PROVIDE GUIDANCE FOR FOLLOW-ON STUDIES IN CREW SELECTION AND COMPOSITION. STUDIES ON TELEOPERATIONS ARE CONCERNED WITH THE DESIGN DECISION PROCESS OF TRADEOFFS BETWEEN MAN VERSUS MANIPULATORS AND TECHNIQUES FOR INCREASING THE VERSATILITY OF TELEFACTORS FOR VARIOUS MISSIONS IN ORBIT, LUNAR, AND PLANETARY SUPPORT AND EXPLORATION.

RTOP NO. 127-51-40 TITLE: SMALL GROUP DYNAMICS AND PERFORMANCE IN SPACE STATIONS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: KLEIN, H. P. TEL. 415-961-1111

TECHNICAL SUMMARY

METHODS FOR ASSESSING THE PERFORMANCE OF INDIVIDUALS AND GROUPS ARE UNDER DEVELOPMENT. THE QUALITY OF INDIVIDUAL PSYCHOLOGICAL ADJUSTMENT, INTERPERSONAL BEHAVIOR, AND TASK-ORIENTED ACTIVITIES ARE BEING CONSIDERED. A BATTERY OF TASK-ORIENTED PERFORMANCE TESTS IS UNDER DEVELOPMENT BASED ON A RECENTLY COMPLETED SURVEY AND ANALYSIS OF PERFORMANCE MEASURES THAT HAVE BEEN USED IN THE PAST. PERFORMANCE CAPABILITIES OF CREWS IN SEVERAL SITUATIONS INVOLVING ISOLATION AND CONFINEMENT ARE BEING, AND WILL BE ASSESSED USING THE AMES CREW EVALUATOR (ACE).

RTOP NO. 127-51-40 TITLE: SPACE STATION - HABITABILITY DESIGN

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: LOUIVERE, A. J. TEL. 713-483-3445

TECHNICAL SUMMARY

HABITABILITY IS CONCERNED WITH THE MAN-MACHINE-ENVIRONMENT-MISSION INTEGRATION AND COVERS THE ELEMENTS: ARCHITECTURE, ENVIRONMENT, FOOD/WATER, GARMENTS, HOUSEKEEPING PERSONAL HYGIENE, MOBILITY/RESTRAINT AND OFF DUTY ACTIVITY. PROPER IMPLEMENTATION OF THESE ELEMENTS INTO A MANNED SPACE SYSTEM WILL ALLOW MAN TO WORK EFFECTIVELY DURING LONG DURATION MISSIONS.

RTOP NO. 127-51-41 TITLE: ASTRONAUT MOBILITY AND WORK IN ZERO- AND ARTIFICIAL-GRAVITY

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

TO PROVIDE DATA ON MAN'S MOBILITY IN A ZERO- AND ARTIFICIAL-GRAVITY ENVIRONMENT USING GUIDE RAILS AND OTHER RESTRAINT SYSTEMS AND CENTRIFUGAL FORCE. TO DEVELOP MISSION AND DESIGN INFORMATION ON THE EFFECTS OF VARIOUS LEVELS OF ARTIFICIAL AND ZERO GRAVITY ON THE ABILITY OF MAN TO PERFORM PHYSICAL WORK. VARIOUS METHODS OF LOCOMOTION INSIDE AND ON THE OUTER SURFACE OF SIMULATED SPACE VEHICLE IN THE CONFIGURATION OF SPACE STATIONS WILL BE STUDIED IN ZERO- AND ARTIFICIAL GRAVITY SIMULATORS. VARIOUS RESTRAINT AND

TETHER MODES WILL BE DEVELOPED AND EVALUATED. DEVELOP INFORMATION ON MAN'S WORK ACTIVITIES IN ZERO- AND ARTIFICIAL-GRAVITY SIMULATORS. OBTAIN QUANTITATIVE MEASURES OF FORCES AND TORQUES HE CAN GENERATE AS WELL AS HIS CAPABILITIES FOR LIFTING, CARRYING, PUSHING, PULLING, HAND AND ARM STEADINESS, AND THE PERFORMANCE OF COMPLEX MOTOR TASKS.

RTOP NO. 127-51-42 TITLE: TELEOPERATOR RESEARCH AND DEVELOPMENT
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-1111
TECHNICAL SUMMARY

RESEARCH AND DEVELOPMENT STUDIES ARE REQUIRED TO DEVELOP TELEOPERATOR SYSTEMS SUITABLE FOR MAINTENANCE AND ASSEMBLY TASKS IN SPACE AND FOR SCIENTIFIC TASKS INVOLVED IN EXPLORATION OF THE LUNAR OR PLANETARY SURFACES. RESEARCH IS PRESENTLY UNDERWAY BY MEANS OF IN-HOUSE AND CONTRACT STUDIES TO EVALUATE THE EFFECTS OF IMPROVED VISUAL FEEDBACK AND TACTILE (KINESTHETIC FEEDBACK) ON REMOTE MANIPULATION TASK PERFORMANCE. RESULTS OF THESE EFFORTS ARE EXPECTED TO PROVIDE USEFUL INPUTS TO BOTH THE DEFINITION AND CONDUCT OF A SPACE STATION TELEOPERATOR EXPERIMENT AND TO THE DEVELOPMENT OF OPERATIONAL TELEOPERATOR SYSTEMS FOR SPACE EXPLORATION AND FOR APPLICATIONS ON EARTH.

RTOP NO. 127-53-22 TITLE: HUMAN FACTORS SYSTEMS PROGRAM REGENERATED
FOOD SYSTEMS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

A MAJOR PROBLEM IN LONG TERM MANNED SPACE VOYAGES IS THAT THE PENALTY FOR CARRYING ALONG FOOD AS AN EXPENDABLE ITEM BECOMES VERY LARGE. EFFORTS HAVE BEEN UNDERWAY FOR A NUMBER OF YEARS TO UTILIZE HUMAN METABOLIC WASTE PRODUCTS FOR REGENERATIVE FOOD PRODUCTION. A CLOSURE OF THE FOOD LOOP COULD RESULT IN SIGNIFICANT SAVINGS IN WEIGHT AND VOLUME FOR LONG DURATION MANNED SPACE MISSIONS. BIOLOGICAL, PHYSICO-CHEMICAL AND COMBINED SYSTEMS ARE CURRENTLY UNDER CONSIDERATION FOR REGENERATIVE FOOD SYSTEMS. THE WORK UNDER THIS RTOP WILL INCLUDE THE FOLLOWING INVESTIGATIONS: (1) THE SYNTHESIS OF FORMALDEHYDE FROM CARBON DIOXIDE; (2) THE SYNTHESIS OF GLYCEROL FROM FORMALDEHYDE; (3) INTEGRATION OF FORMALDEHYDE AND GLYCEROL SYNTHESIS SYSTEMS; (4) THE SYNTHESIS AND CHARACTERIZATION OF FORMOSE SUGAR MIXTURES (OBTAINED FROM THE CONDENSATION OF FORMALDEHYDE); AND (5) THE FRACTIONATION OF THE HETEROGENEOUS FORMOSE MIXTURE BY STABILIZED ENZYME SYSTEMS TO EXTRACT GLUCOSE OR FRUCTOSE FROM THE MIXTURE.

RTOP NO. 127-53-24 TITLE: LIFE SUPPORT AND PROTECTIVE SYSTEMS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: DUNNING, R. W. TEL. 202-962-0036
TECHNICAL SUMMARY

THE EMPHASIS IS ON ADVANCED TECHNOLOGY FOR PURIFICATION OF AIR,

WATER AND WASTE IN THE SHUTTLE AND SPACE STATION/SPACE BASE MISSIONS AND WORKING WITH OTHER AGENCIES ON LIFE SUPPORT DEVICES OF MUTUAL INTEREST. SUPPLEMENTING THIS ARE ADVANCED STUDIES IN THE LIFE SUPPORT AREAS.

RTOP NO. 127-53-32 TITLE: MANNED SPACE SHUTTLE: STUDIES OF
PERSONNEL RESTRAINT AND SUPPORT SYSTEM

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: KLEIN, H. P. TEL. 415-961-2735

TECHNICAL SUMMARY

PROPOSED SPACE SHUTTLE OPERATION IMPOSES ON THE CREW AND PASSENGERS AN ACCELERATION ENVIRONMENT (+GSUBZ, EYEBALLS DOWN) NOT ENCOUNTERED IN PREVIOUS MANNED SPACE FLIGHT OPERATIONS. RESEARCH IS NECESSARY TO DEFINE THE OCCUPANT'S TOLERANCE AND PERFORMANCE LEVELS FOR THE +GSUBZ REENTRY ACCELERATIONS ANTICIPATED FOR SHUTTLE VEHICLES HAVING FIXED SEATS ORIENTED IN THE ATTITUDE USED FOR CONVENTIONAL AIRCRAFT. A SERIES OF EXPERIMENTS USING AMES' SIMULATORS WILL BE CONDUCTED TO PROVIDE INFORMATION NECESSARY TO DESIGN CREW/PASSENGER SEAT AND RESTRAINT SYSTEMS. REENTRY ACCELERATION PROFILES IN THE RANGE OF 2 TO 4 G'S WILL BE SIMULATED USING SUBJECTS REPRESENTATIVE OF THE SPACE SHUTTLE CREW AND PASSENGER POPULATION, I.E., PILOTS AND MALES AND FEMALES IN THE AGE GROUP OF 25 TO 50. DECONDITIONING DUE TO PROLONGED PERIODS OF WEIGHTLESSNESS WILL BE SIMULATED BY BED REST FOR PERIODS OF UP TO ONE MONTH (OR LONGER, IF APPROPRIATE). IN ADDITION, A MATHEMATICAL MODEL OF THE DYNAMIC RESPONSE OF THE HUMAN VERTEBRAL COLUMN TO POTENTIAL IMPACT ACCELERATIONS WILL BE DEVELOPED.

RTOP NO. 127-53-34 TITLE: SHUTTLE PROTECTIVE SYSTEMS

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: CARPENTER, L. R. TEL. 805-258-3311

TECHNICAL SUMMARY

A. RESEARCH TO DATE IN PROTECTIVE AND RESTRAINT DEVICES HAS NOT BEEN ORIENTED TOWARDS AN INTEGRATED IMPACT SURVIVAL SYSTEM. THIS RTOP IS TO STUDY THE PROBLEMS OF PRODUCING A UNIFIED INTEGRATED SAFETY SYSTEM TO PROTECT CREWS DURING THOSE SITUATIONS WHICH REQUIRE THE MAXIMUM IN INDIVIDUAL SAFETY PROTECTION BUT WHICH MAY OCCUR IN VEHICLES WHICH CANNOT UTILIZE EJECTION SEAT TECHNOLOGY. THE APPROACH IS TO DESIGN, DEVELOP AND FABRICATE PROTECTIVE SYSTEMS FOR RESEARCH FLIGHT VEHICLES AND MEASURE THEIR CAPABILITIES DURING INSTRUMENTED DROP TESTS AND FLIGHT TESTS, AND UTILIZE THE DATA SO OBTAINED TO DESIGN SYSTEMS FOR MANNED FLIGHTS. B. PERSONNEL THERMAL CONTROL PROBLEMS HAVE BEEN ENCOUNTERED AT THE FLIGHT RESEARCH CENTER IN ALL LIFTING BODY CONFIGURATIONS BEING FLOWN. THIS PROGRAM IS UNDERWAY TO SOLVE THE THERMAL PROBLEM FOR TWO AND LATER SEVEN HOURS MISSION DURATION.

RTOP NO. 127-53-35 TITLE: SPACE SHUTTLE EC/LS SYSTEM INTERFACE AND
CONTAMINANT STUDIES

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

A LIFE SUPPORT SYSTEM IS REQUIRED FOR THE SPACE SHUTTLE WHICH IS CAPABLE OF OPERATING IN CONJUNCTION WITH THAT OF THE SPACE STATION/SPACE BASE SYSTEM; WHICH CAN BE STORED FOR LONG PERIODS IN ORBIT AND THEN STARTED; WHICH HAS THE REQUIRED AUTOMATIC CHECKOUT, RELIABILITY, AND SHORT TURNAROUND-TIME REFURBISHMENT CHARACTERISTICS; WHICH HAS MINIMUM WEIGHT IN ORDER TO MAXIMIZE THE PAYLOAD CAPABILITY OF THE SHUTTLE; AND WHICH HAS THE CAPABILITY TO CONTROL CABIN CONTAMINANTS FOR A VARIETY OF PAYLOADS. IN ORDER TO INSURE TIMELY AVAILABILITY OF SHUTTLE LIFE SUPPORT SYSTEM TECHNOLOGY IN-HOUSE AND CONTRACTUAL STUDIES WILL BE MADE OF DATA AND SUBSYSTEMS APPLICABLE TO THE SHUTTLE MISSION, AND PROBLEM AREAS WILL BE IDENTIFIED. THEN CRITICAL COMPONENTS REQUIRED TO INVESTIGATE FACTORS SUCH AS SYSTEM STORAGE AND STARTUP CONTAMINANT CONTROL, AND INTERFACES BETWEEN THE OPEN-CYCLE SHUTTLE SUBSYSTEM AND REGENERATIVE SPACE STATION SUBSYSTEMS WILL BE PROCURED AND TESTED. ALSO, ADVANCES IN COMPONENT STATE-OF-THE-ART WILL BE CONTINUALLY EXAMINED IN AN EFFORT TO UPDATE SYSTEM RELIABILITY AND MINIMIZE WEIGHT. THE NOMINAL MISSION LENGTH OF 7 DAYS INDICATES THAT MAXIMUM USE SHOULD BE MADE OF APOLLO OPEN CYCLE HARDWARE FOR THE SHUTTLE LIFE SUPPORT SYSTEM. HOWEVER, A TWO-GAS SHIRT SLEEVE CABIN ATMOSPHERE CONSISTING OF OXYGEN AND NITROGEN IS REQUIRED, WHICH MEANS THAT ADDITION OF A SUPPLY OF STORED NITROGEN WILL BE NECESSARY AND ALSO A TWO-GAS ATMOSPHERE SENSOR AND CONTROL SYSTEM. ALSO, CONSIDERATION OF PASSENGERS WHO ARE NOT AS HIGHLY QUALIFIED OR AS WELL TRAINED AS ASTRONAUTS WILL REQUIRE MODIFICATIONS TO PERSONAL ACCOMODATIONS SYSTEMS INVOLVING WASTE MANAGEMENT AND CABIN TEMPERATURE CONTROL.

RTOP NO. 127-53-40 TITLE: SPACE STATION LIFE SUPPORT AND PROTECTIVE
SYSTEMS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: KLEIN, H. P. TEL. 000-961-1111

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP LIFE SUPPORT SYSTEM AND SUBSYSTEM TECHNOLOGY TO SUPPORT ADVANCED MAN SPACE MISSIONS SUCH AS THE SPACE STATION. THE LIFE SUPPORT TECHNOLOGY REQUIREMENTS FOR SUCH A MISSION INCLUDE: REGENERATION OF OXYGEN AND WATER FROM METABOLIC AND OTHER WASTES; SUITABLE MANAGEMENT TECHNIQUES AND DEVICES FOR TREATMENT OF LIQUID AND SOLID WASTES; SENSING AND CONTROL OF CONTAMINANTS IN THE SPACE CABIN ATMOSPHERE AND WATER; ADVANCED SPACE SUIT RESEARCH; THERMAL CONTROL SYSTEMS; AND ADVANCED PORTABLE LIFE SUPPORT SYSTEMS FOR BACKPACKS.

RTOP NO. 127-53-40 TITLE: SPACE STATION - LIFE SUPPORT AND
PROTECTIVE SYSTEMS

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: GILLEN, R. J. TEL. 713-483-4061

TECHNICAL SUMMARY

THIS RTOP WILL PROVIDE FOR THE ORDERLY DEVELOPMENT OF LIFE SUPPORT AND PROTECTIVE SYSTEMS FOR SPACE STATION/SPACE BASE APPLICATIONS. THE REQUIRED TECHNOLOGY BASE DICTATES THAT CERTAIN IMPROVEMENTS BE ACHIEVED IN ANALYTICAL TECHNIQUES AND IN HARDWARE DEVELOPMENTS. THE HARDWARE DEVELOPMENTS ARE INTENDED TO RESULT IN THE FABRICATION AND CAREFUL EVALUATION OF FULL-SCALE DEVELOPMENT UNITS IN THE SPECIFIC AREAS OF WATER AND WASTE MANAGEMENT, ATMOSPHERE SUPPLY AND CONTROL AND IVA SPACE SUITS. THE ANALYSIS METHOD DEVELOPMENTS ARE INTENDED TO PROVIDE PERFORMANCE PREDICTIONS AND INDICATE LSS SUBSYSTEM INTERACTIONS.

RTOP NO. 127-53-41 TITLE: SPACE STATION LIFE SUPPORT

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

BECAUSE OF THE LONG DURATION OF PROPOSED MISSIONS, REGENERATIVE ENVIRONMENTAL CONTROL/LIFE SUPPORT SYSTEMS WILL BE REQUIRED FOR MANNED SPACE STATIONS AND SPACE BASES. BASICALLY IT IS NECESSARY TO PROVIDE METHODS FOR RECOVERING OXYGEN FROM EXPIRED CARBON DIOXIDE AND POTABLE WATER FROM URINE, WASH WATER, AND HUMIDITY CONDENSATE. SPECIFICALLY, HARDWARE AND TECHNIQUES MUST BE DEVELOPED FOR ATMOSPHERE STORAGE AND MAKEUP; CO2 CONCENTRATION; CO2 REDUCTION; ELECTROLYSIS; CONTAMINANT SENSING AND CONTROL; TEMPERATURE AND HUMIDITY CONTROL; WASTE WATER COLLECTION, RECLAMATION, AND DISPENSING; PERSONAL HYGIENE; WASTE MANAGEMENT; AND FOR REQUIRED INSTRUMENTATION. IN ADDITION, THESE SUBSYSTEMS MUST BE SCALED UP TO REALISTIC CAPACITIES; INTEGRATED INTO COMPLETE SYSTEMS WITH EMPHASIS ON AUTOMATION, RELIABILITY, MAINTAINABILITY, AND PACKAGABILITY; AND PERFORMANCE DEMONSTRATED BY MEANS OF MANNED AND UNMANNED TESTS. RESEARCH IS UNDERWAY AND WILL CONTINUE BOTH IN-HOUSE AND UNDER CONTRACT TO INVESTIGATE PROMISING CANDIDATE APPROACHES TO PROVIDING THE REQUIRED LIFE SUPPORT FUNCTIONS. OPERATIONAL HARDWARE IS BEING DEVELOPED AND TESTED, AND LONG DURATION CLOSED DOOR MANNED TESTS INVOLVING COMPLETE ON-BOARD REGENERATIVE LIFE SUPPORT SYSTEMS ARE EITHER UNDERWAY OR PLANNED. EMPHASIS ON THE ROLE OF MAN AS A PART OF THESE SYSTEMS IS BEING INCREASED IN THE CURRENT AND PLANNED PROGRAMS.

SUPPORT RESEARCH IN MICROBIOLOGY IS UNDERWAY AND CAPABILITY FOR LABORATORY AND IN-FLIGHT MICROBIOLOGICAL, WATER POTABILITY, CHEMICAL AND PARTICLE, AND ATMOSPHERIC MONITORING IS BEING STRENGTHENED.

RTOP NO. 128-31-60 TITLE: TECHNOLOGY IDENTIFICATION & TEST
MEASUREMENTS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: WEEKS, P. TEL. 213-354-2546

TECHNICAL SUMMARY

THE GOALS OF THIS WORK ARE: (1) TO EVALUATE THE STATE OF THE ART OF MEASURING ROCKET ENGINE PERFORMANCE, CONTRIBUTE TO THE NATIONAL EFFORT UNDER THE PERFORMANCE STANDARDIZATION WORKING GROUP BOTH IN ASSESSING THE PROCEDURES SET OUT IN CPIA REPORT NO. 178, AND DEVELOP CAPABILITIES FOR ACCURATE PERFORMANCE EVALUATION UNDER CONDITIONS BEYOND THE SCOPE OF THAT REPORT. (2) DEVELOP SPECIAL INSTRUMENTATION AND DEVISE NEW TECHNIQUES FOR OBTAINING PERFORMANCE DATA FROM PROPULSION SYSTEMS. (3) DEVELOP THE SOFTWARE REQUIRED TO IMPLEMENT AND VERIFY (1).

RTOP NO. 128-31-60 TITLE: TECHNOLOGY IDENTIFICATION

ORGANIZATION: HEADQUARTERS

MONITOR: LEVINE, R. S. TEL. 202-962-1703

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO ACCOMPLISH ACTIVITIES IN THE NATURE OF SPECIAL OR SELECTED PROJECTS. THESE PROJECTS FALL INTO FOUR DISTINCT CATEGORIES. (1) INTERDEPARTMENTAL PURCHASE REQUESTS WHICH ARE OF A GENERAL NATURE (2) PROJECTS WHICH ARE PART OF MULTI-CENTER EFFORTS, (3) TO EXPEDITIOUSLY IMPLEMENT AN EFFORT TO SATISFY A NEW OR URGENT REQUIREMENT, (4) TO INITIATE AN ACTIVITY TO SERVE AS A "SEED PROGRAM" FOR EXPANSION OF A CENTER'S EXISTING CAPABILITY.

RTOP NO. 128-31-61 TITLE: AUXILIARY PROPULSION SYSTEM COMPONENT
TECHNOLOGY

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: NORED, D. L. TEL. 216-433-6873

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE IMPROVEMENTS IN THE TECHNOLOGY OF COMPONENTS FOR SMALL HYDROGEN-OXYGEN ENGINES. THESE ENGINES WOULD BE APPLICABLE TO THE AUXILIARY PROPULSION SYSTEM FOR THE SPACE SHUTTLE VEHICLE. THIS WORK WILL BE DEVOTED TO ADVANCEMENTS IN SUCH AREAS AS IGNITION SYSTEMS, PROPELLANT VALVES, BASIC INJECTION TECHNIQUES, AND COOLING. THE PROGRAM WILL BE PURSUED THROUGH BOTH ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS DESIGNED TO EVALUATE THOROUGHLY THE BASIC CRITICAL PROBLEMS UNIQUE TO EACH AREA AND TO ESTABLISH DATA NECESSARY FOR RELIABLE DESIGN. THE WORK WILL INCLUDE ANALYSIS AND DESIGN, COLD FLOW TESTING WITH SIMULANT FLUIDS, AND HOT FIRING TESTS USING GASEOUS HYDROGEN-GASEOUS OXYGEN PROPELLANTS. AS NEW TECHNOLOGY NEEDS ARE IDENTIFIED BY THE VARIOUS SPACE SHUTTLE VEHICLE STUDIES, NEW EFFORTS WILL BE INITIATED, AS NECESSARY.

RTOP NO. 128-31-62 TITLE: AUXILIARY PROPULSION FOR REUSABLE SPACE SHUTTLE VEHICLE

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: LITTLES, W. TEL.

TECHNICAL SUMMARY

THE PURPOSE OF THIS STUDY IS TO EXPERIMENTALLY INVESTIGATE THE EFFECTS OF LOW GRAVITY LEVELS ON THE INCIPIENT BOILING POINT ON CRYOGENS. UTILIZATION OF THE UNIVERSITY OF MICHIGAN DROP TOWER FACILITY USING LIQUID HYDROGEN AS THE TEST LIQUID IS PROPOSED TO INVESTIGATE THE EFFECTS OF NEAR ZERO GRAVITY. A KNOWLEDGE OF ZERO GRAVITY BOILING IS ESSENTIAL FOR THE DESIGN OF CRYOGEN PROPELLANT ACQUISITION AND CONDITIONING SYSTEMS. ORBITAL TESTING IS REQUIRED FOR VERIFICATION OF BOILING HEAT TRANSFER TECHNOLOGY USED TO DESIGN SHUTTLE SYSTEMS.

RTOP NO. 128-31-63 TITLE: MAIN PROPULSION FOR SPACE SHUTTLE VEHICLE

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

THIS RTOP WILL PROVIDE PROPULSION TECHNOLOGY TO UPGRADE THE CAPABILITY OF PROPULSION SYSTEMS SO AS TO ACHIEVE CONSIDERABLE OPERATIONAL VERSATILITY AND HIGH PERFORMANCE REQUIRED BY EARTH ORBIT LOGISTICS VEHICLES, PARTICULARLY THE SPACE SHUTTLE. THE EFFORT PERFORMED UNDER THIS RTOP WILL SUSTAIN INVESTIGATIONS OF NEW CONCEPTS AND TECHNIQUES THROUGH ANALYSIS, PRELIMINARY DESIGN, AND TESTING. EFFORT IS IDENTIFIED WHICH HAS THE POTENTIAL FOR MAKING SATURATED CRYOGENIC PROPELLANT USE AN OPERATIONAL REALITY, MAKING CAVITATING INDUCER INSTABILITY LESS TROUBLESOME, INCREASING THE VERSATILITY OF ENGINE AND FEED SYSTEM TEMPERATURE CONDITIONING METHODS, PROVIDING A METHOD OF MIXTURE RATIO MEASUREMENT USING SPECTROGRAPHIC METHODS, PREDICTING AND AVOIDING FAILURES OF TURBOPUMPS DUE TO ROTATING ASSEMBLY DYNAMIC PROBLEMS. SEVEN TASKS ARE OUTLINED WHICH PROVIDE FOR INVESTIGATION OF TWO PHASE INDUCERS, CAVITATING INDUCER INSTABILITIES, HYDROGEN PUMP AND FEED LINE LINERS, OPERATION OF LOX/LH2 PUMP FED ENGINES ON SATURATED PROPELLANTS, FURTHER DEVELOPMENT OF THE TANDEM INDUCER CONCEPT, INVESTIGATION OF SPECTROGRAPHIC MIXTURE RATIO MEASUREMENT AND IMPROVED SIMULATION TECHNIQUES OF TURBOPUMP ROTATING ASSEMBLY DYNAMICS. BOTH IN-HOUSE AND CONTRACTED EFFORTS ARE PLANNED.

RTOP NO. 128-31-64 TITLE: HYDROGEN-OXYGEN PROPULSION TECHNOLOGY, STS

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: NORED, D. L. TEL. 216-433-4000

TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS PROGRAM IS TO PROVIDE CONCEPTUAL DESIGN DATA FOR FEED SYSTEM COMPONENTS AND SUB-SYSTEMS FOR HYDROGEN-OXYGEN ENGINES, THEREBY PROVIDING IMPROVED CAPABILITY FOR SPACE TRANSPORTATION VEHICLES SUCH AS THE SPACE SHUTTLE. IN F.Y. 1971, THIS WORK WILL BE DEVOTED TO TURBOMACHINERY DESIGN AND FEED SYSTEM DYNAMICS.

RTOP NO. 128-31-64 TITLE: SHUTTLE MAIN ENGINE TECHNOLOGY
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: YODZIS, C. TEL. 713-483-4924
TECHNICAL SUMMARY

THREE SPECIAL TECHNOLOGY AREAS ASSOCIATED WITH HIGH PRESSURE COMBUSTION OF H₂/O₂ PROPELLANTS WILL BE ADVANCED TO COMPLIMENT THE SHUTTLE MAIN ENGINE DEVELOPMENT. THE AREAS ARE: (A) INJECTOR ACOUSTIC CAVITIES, (B) NONCIRCULAR INJECTOR ORIFICES, AND (C) NOZZLE PERFORMANCE EFFECTS CAUSED BY STRAITED PROPELLANT INJECTION. THE ACOUSTIC CAVITY HAS EVOLVED OVER THE LAST SEVERAL YEARS AS A STABILIZING DEVICE FOR SEVERAL CAVITIES OR SLOTS IN OR NEAR THE INJECTOR FACE TO ELIMINATE BAFFLES AND PROVIDE COMBUSTION STABILITY FOR MAN RATED HIGH PRESSURE H₂/O₂ ENGINES. MODERN MACHINING TECHNIQUES HAVE PRODUCED A UNIQUE CAPABILITY TO FABRICATE INJECTORS WHICH DO NOT REQUIRE DRILL PRESS POSITIONING OR CIRCULAR HOLES. THIS TECHNOLOGY HAS PRODUCED NONCIRCULAR LIQUID/LIQUID INJECTORS WITH CRYOGENIC PROPELLANTS. NOZZLE PERFORMANCE DEGRADATIONS CAUSED BY STRAITED PROPELLANTS, MIXTURE RATIO, AND MASS FLOW VARIATION WILL BE EXPERIMENTALLY INVESTIGATED TO PROVIDE ACCURATE DATA WHICH WILL BE USED TO DETERMINE THE ACCURACY OF JANNAF COMPUTER PROGRAMS.

RTOP NO. 128-31-66 TITLE: LIQUID PROPULSION TECHNOLOGY FOR
PLANETARY EXPLORATION

ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. J. TEL. 213-354-2546
TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS TO MEASURE AND DETERMINE THE TRAJECTORIES OF ROCKET EXHAUST PLUME EFFLUX, ESTABLISH MECHANISMS FOR PREDICTING THIS FLOW IN SPACE, AND ESTABLISH THE EFFECTS OF IMPINGEMENT ON PROXIMATE BODIES AS WELL AS ON THE SPACECRAFT PRODUCING THE PLUME. WORK UNDER THIS UNIT IN FUTURE FISCAL YEARS WILL INCLUDE INVESTIGATIONS OF THE EFFECTS UPON SPACECRAFT SURFACES OF EXHAUST PLUMES FROM ROCKETS USING SPACE STORABLE PROPELLANTS SUCH AS OF₂/B₂H₆. THE FY'71 EFFORT WILL CONSIST OF EXPLORATORY MEASUREMENTS OF THE SCATTER ANGLE OF FLUORESCENT DROPLETS BEING EJECTED FROM THE NOZZLE LIP WITH EMPHASIS UPON FLOW IN A REVERSE DIRECTION (GREATER THAN 90 DEGREES FROM THE FLOW AXIS). DATA WILL BE TAKEN OVER A RANGE OF DIFFERENT NOZZLE PLUME PROFILES. MEASUREMENTS WILL BE MADE USING JPL'S MOLSINK FACILITY. CALIBRATIONS OF THIS FACILITY HAVE SHOWN THAT FULL PLUME EXPANSION, INCLUDING THE REVERSE FLOW, CAN BE MAINTAINED FOR LONG TEST TIMES WHILE INJECTING N₂ GAS AT RATES EXCEEDING 3 GRAMS/SEC. THE ASSOCIATED BACK PRESSURE WAS .00001 TORR. CORRELATIONS WILL BE MADE BETWEEN PLUME FLOWFIELD CONDITIONS AND DROPLET TRAJECTORIES. BECAUSE THE BACK-SCATTERED DROPLETS ORIGINATE IN THE REGION OF THE NOZZLE BOUNDARY LAYER, AND THE GASES FROM THE NOZZLE BOUNDARY LAYER EXPAND TO A LARGER DEGREE THAN PREDICTED BY ANALYTICAL METHODS NOW BEING USED, CLOSE ATTENTION WILL BE DIRECTED TO DETERMINE HOW THIS INFLUENCES THE MECHANISM FOR PARTICLE TURNING. FLOWFIELD DENSITIES AND PRESSURES WILL BE MAPPED BY THE ELECTRON BEAM FLUORESCENCE TECHNIQUE USING EQUIPMENT DESIGNED FOR USE IN THE MOLSINK. THE RESULTS OF THE WORK WILL BE EXPERIMENTAL DATA NECESSARY TO ACCURATELY PREDICT THE REVERSE FLOW SCATTERING OF

SOLID AND LIQUID PARTICLE AND GASES AND THEIR IMPINGEMENT ON SENSITIVE SPACECRAFT SURFACES, E.G., OPTICAL SURFACES SENSORS AND THERMAL CONTROL SURFACES.

RTOP NO. 128-31-70 TITLE: FEED SYSTEM AND ENGINE ACCESSORIES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: HECKS, P.

TEL. 213-354-2546

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TECHNOLOGY EFFORT IS TO PROVIDE A STRONG TECHNOLOGY BASE FOR CHEMICAL PROPULSION SYSTEMS THAT WILL BE USED ON ADVANCED TYPE SPACECRAFT IN THE MID 1970'S. REQUIREMENTS ARE RELATED TO NEAR AND LONG TERM PLANETARY MISSIONS. THE WORK IS PRIMARILY DIRECTED TOWARD THE PROPELLANT COMBINATION OXYGEN DIFLUORIDE (OF₂) AND DIBORANE (B₂H₆). OTHER PROPELLANTS BEING CONSIDERED INCLUDE LIQUID FLUORINE (LF₂) AND SOME EARTH STORABLES (I.E., NITROGEN TETROXIDE, (N₂/4); HYDRAZINE (N₂H₄); AND HYDRAZINE MIXES). THE ADVANCED DEVELOPMENT EFFORTS WHICH SUPPORT THE OVERALL R/AD PROGRAM FOR FEED SYSTEM AND ENGINE ACCESSORIES, RTOP NUMBER 128-31-70, ARE PRESENTED. THIS INCLUDES BOTH IN-HOUSE AND CONTRACT TASKS. THE WORK IS RELATED TO FOUR GENERIC TECHNOLOGY AREAS: (1) FEED SYSTEM AND ENGINE ACCESSORIES; (2) PROPELLANT PERFORMANCE; (3) ENVIRONMENTAL EFFECTS ON MATERIALS; (4) COMPONENTS: (VALVES, CONTROLLERS, FABRICATION, ETC.).

RTOP NO. 128-31-70 TITLE: FEED SYSTEMS AND ENGINE ACCESSORIES

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: GREGORY, J.

TEL. 216-433-6874

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE IMPROVEMENTS IN THE TECHNOLOGY OF ROCKET ENGINE FEED SYSTEMS AND ENGINE ACCESSORIES. THE MAJOR PORTION OF THIS WORK WILL BE DEVOTED TO ADVANCEMENTS IN THE TURBOMACHINERY AREA, AND WILL INCLUDE INVESTIGATION OF (1) AXIAL FLOW PUMPS, (2) SMALL CENTRIFUGAL AND POSITIVE DISPLACEMENT PUMPS, (3) INDUCER DESIGN, (4) CAVITATION IN CRYOGENIC PROPELLANTS, (5) TURBOPUMP DYNAMICS AND (6) BEARINGS AND SEALS. THE PROGRAMS WILL BE DESIGNED TO FURTHER OUR KNOWLEDGE OF BLADE AND INDUCER DESIGN, FLUID FLOW PROCESSES, AND PUMP PERFORMANCE LOSSES. WORK WILL ALSO BE DEVOTED TO IMPROVEMENTS IN PRESSURIZATION SYSTEMS AND TO THE PREVENTION OF PARTICULATE CONTAMINATION IN VALVE SEATS, AS REQUIRED FOR RELIABILITY IN LONG-TERM MISSIONS. THE PROGRAM OBJECTIVES WILL BE PURSUED LARGELY THROUGH PROGRAMS USING CRYOGENIC PROPELLANTS AND SPACE STORABLE PROPELLANTS.

RTOP NO. 128-31-76 TITLE: LIQUID ROCKET THRUST CHAMBER AND INJECTOR
DESIGN

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: WEEKS, P. J. TEL. 213-354-2546

TECHNICAL SUMMARY

ONE OBJECTIVE OF THIS WORK IS TO GENERATE INJECTOR AND THRUST CHAMBER DESIGN CRITERIA AND A TECHNOLOGY BASE FOR LIQUID ROCKET SPACECRAFT ENGINES IN THE 200 TO 5000-LB-THRUST CLASS USING THE SPACE-STORABLE PROPELLANT COMBINATION OF $\text{OF}_2/\text{B}_2\text{H}_6$. THE GOAL IS AN ENGINE CONCEPT WHICH CAPABLE OF MULTIPLE RESTARTS, UNLIMITED DURATION, SIMPLIFIED DESIGN, AND HIGH PERFORMANCE. THIS WILL BE ACCOMPLISHED THROUGH A COORDINATED PROGRAM WHICH GENERATES OPTIMIZATION PARAMETERS WHILE PRODUCING DESIGN INFORMATION ON PERFORMANCE, STABILITY, HEAT FLUX, COMPATIBILITY GEOMETRY EFFECTS, AND SUITABILITY OF VARIOUS COOLING TECHNIQUES. BOUNDARY OR RADIATION-COOLED THRUST CHAMBERS AS WELL AS MORE COMPLEX COOLING TECHNIQUES BASED ON HEAT PIPES WILL BE EVALUATED. REDUCTION OF HEAT FLUX WILL BE ACTIVELY PURSUED THROUGH THE USE OF TECHNIQUES SUCH AS MIXTURE RATIO GRADIENTS AT THE WALL AND FILM COOLING. COOLING EFFECTS ON PERFORMANCE WILL BE STUDIED. ANOTHER OBJECTIVE OF THE WORK IS TO PERFECT A SPONTANEOUS CATALYST BED FOR MONOPROPELLANT HYDRAZINE DECOMPOSITION BASED ON A POROUS MONOLITHIC METALLIC SUBSTRUCTURE. SUCH A CATALYST IS REQUIRED TO WITHSTAND THE HIGHER OPERATING TEMPERATURES OF HYDRAZINE/HYDRAZINIUM NITRATE PROPELLANT BLENDS BEING CONSIDERED FOR HIGHER SPECIFIC IMPULSE MONOPROPELLANT APPLICATIONS. A THIRD GOAL IS TO DESIGN, FABRICATE, AND TEST A THRUST CHAMBER ASSEMBLY FOR FLUORINE-HYDRAZI PROPELLANTS THAT IS CAPABLE OF OPERATING IN EITHER A MONOPROPELLANT OR A BIPROPELLANT MODE. SUCH A MOTOR IS OF INTEREST FOR CERTAIN ANTICIPATED SPACECRAFT APPLICATIONS, BECAUSE IT WOULD BE CAPABLE OF PERFORMING BOTH TRAJECTORY CORRECTION AND ORBIT INSERTION MANEUVERS.

RTOP NO. 128-31-76 TITLE: THRUST CHAMBERS AND INJECTORS

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: GREGORY, J. W. TEL. 216-433-4000

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE A BETTER UNDERSTANDING OF INJECTOR AND INJECTION ELEMENT DESIGN EFFECTS ON BOTH COMBUSTION EFFICIENCY AND THRUST CHAMBER HEAT TRANSFER, ALONG WITH DEVELOPMENT OF IMPROVED MATERIALS AND CHAMBER FABRICATION TECHNIQUES FOR LOWER COST, HIGHER HEAT FLUX, AND MORE DESIGN FLEXIBILITY (FOR CHANGES IN OPERATING CONDITIONS OR PROPELLANTS). IMPROVEMENTS IN THE ABILITY TO COPE WITH HIGH HEAT FLUX LEVELS WILL BE OBTAINED THROUGH THE DEVELOPMENT OF REFRACTORY METAL OR CERAMIC COATINGS APPLIED TO THE INNER WALLS OF REGENERATIVE CHAMBERS. INJECTOR TECHNOLOGY DEVELOPMENT PROGRAMS WILL BE UNDERTAKEN TO PROVIDE KNOWLEDGE ON THE EFFECT OF INJECTOR DESIGN VARIABLES UPON COMBUSTION EFFICIENCY AND ON HEAT FLUX TO THE THRUST CHAMBER WALLS. THESE PROGRAMS WILL BE APPLIED PRINCIPALLY TO THE HIGH ENERGY CRYOGENIC AND SPACE STORABLE PROPELLANTS, ALTHOUGH MANY OF THE RESULTS WILL BE GENERALLY APPLICABLE TO OTHER PROPELLANTS. INVESTIGATIONS WILL ALSO BE MADE OF SMALL ATTITUDE CONTROL SIZE

ROCKET THRUSTERS FOR USE ON AN ORBITING SPACE STATION THAT WOULD USE HYDROGEN-OXYGEN-METHANE PROPELLANT. DEVELOPMENT OF MONOLITHIC CATALYST BEDS FOR HYDRAZINE DECOMPOSITION WILL BE INITIATED.

RTOP NO. 128-31-80 TITLE: PROPELLANT PROPERTIES AND PERFORMANCE
ORGANIZATION: JET PROPULSION LAB.

MONITOR: WEEKS, P. TEL. 213-354-2546

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO PROVIDE A STRONG TECHNOLOGY BASE FOR UNDERSTANDING THE BEHAVIOR OF CHEMICAL PROPELLANTS THAT WILL BE USED ON ADVANCED SPACECRAFT. REQUIREMENTS ARE RELATED TO NEAR AND LONG TERM PLANETARY MISSIONS. THE WORK IS DIRECTED TOWARD THE SPACE STORABLE PROPELLANTS OXYGEN DIFLUORIDE (OF₂) AND DIBORANE (B₂H₆) AND OTHER PROPELLANTS INCLUDING LIQUID FLUORINE (LF₂); NITROGEN TETROXIDE; (N₂O₄); HYDRAZINE (N₂H₄); AND HYDRAZINE BLENDS.

RTOP NO. 128-31-90 TITLE: COMBUSTION AND IGNITION
ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: PRIEM, R. J. TEL. 216-433-4000

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO PROVIDE NEW TECHNOLOGY IN THE AREA OF COMBUSTION AND IGNITION PHENOMENA IN LIQUID ROCKETS, WHICH CAN BE USED IN FUTURE SPACE AND LAUNCH VEHICLE ENGINES TO OBTAIN IMPROVED RELIABILITY (STABLE COMBUSTION, CONTROLLED IGNITION AND RESTART, NO COMBUSTION CHAMBER HOT SPOTS), HIGH PERFORMANCE, AND REDUCED DEVELOPMENT COSTS. A PRELIMINARY INVESTIGATION WILL ALSO BE INITIATED TO DETERMINE WHETHER LIQUID ROCKET COMBUSTION TECHNOLOGY CAN BE APPLIED TO CONTROL THE AIR POLLUTION CAUSED BY INTERNAL COMBUSTION ENGINES. THESE OBJECTIVES WILL BE ATTAINED THROUGH: 1) THEORETICAL STUDIES TO DELINEATE THE IMPORTANT DESIGN PARAMETERS FOR ACHIEVING HIGH PERFORMANCE AND RELIABILITY, 2) EXPERIMENTAL STUDIES TO YIELD QUANTITATIVE KNOWLEDGE TO DEMONSTRATE THE VALIDITY OF SPECIFIC THEORETICAL APPROACHES AND/OR DESIGN PARAMETERS, AND 3) EXPLORATORY STUDIES TO INVESTIGATE NEW TECHNIQUES OR THEORETICAL APPROACHES THAT WILL AID IN OBTAINING HIGH PERFORMANCE AND RELIABILITY.

RTOP NO. 128-31-90 TITLE: COMBUSTION AND IGNITION
ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MEEKS, J. TEL. 213-354-2546

TECHNICAL SUMMARY

EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF THE COMBUSTION PROCESSES IN A LIQUID PROPELLANT ROCKET ENGINE ARE BEING CONDUCTED IN ORDER TO PROVIDE DESIGN CRITERIA REQUIRED FOR THE APRIORI SPECIFICATION OF STABLE, RELIABLE, AND HIGH PERFORMANCE ROCKET ENGINES UTILIZING HIGH ENERGY LIQUID PROPELLANTS. THIS INFORMATION WILL BE USED IN WORK UNDER THE RTOP, ENTITLED "LIQUID ROCKET THRUST CHAMBER AND INJECTOR DESIGN" (128-31-76), BY THE 731 PROGRAM ADVANCED

EXPERIMENTAL ENGINES AND BY USER AGENCIES SUCH AS OMSF AND OSSA TO IMPROVE THEIR ENGINES. THE JPL PROGRAM ON COMBUSTION INSTABILITY WILL BE DISTINGUISHED FROM THAT OF OTHER AGENCIES BY THE EMPHASIS ON THE DETONATION-LIKE CHARACTERISTICS OF TRANSITION TO AND SUSTENANCE OF THE DESTRUCTIVE RESONANT COMBUSTION MODE. MEANS FOR INHIBITING AND CONTROLLING SUCH DISTURBANCES WILL BE SOUGHT. GOVERNMENT/INDUSTRY EFFORT TO STANDARDIZE ON THE METHODOLOGY AND PROCEDURES UTILIZED IN THE CALCULATION OF PERFORMANCE OF ROCKET ENGINES --- PARTICULARLY AS APPLIED TO THE EXTRAPOLATION TO PERFORMANCE IN SPACE FROM GROUND LEVEL SUB-SCALE EXPERIMENTS WILL BE COORDINATED. THE SOFTWARE REQUIRED TO IMPLEMENT AND THE METHODOLOGY WILL BE DEVELOPED.

RTOP NO. 128-31-95 TITLE: HEAT TRANSFER AND FLUID FLOW PROCESSES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: WHITCOMB, R. T. TEL. 703-827-2252
TECHNICAL SUMMARY

A ROCKET EXHAUSTING INTO EITHER A MOVING OR A QUIESCENT ATMOSPHERE CAUSES, THROUGH VISCOUS INTERACTION, SUBSTANTIAL CHANGES IN THE BASIC STRUCTURES OF THE SURROUNDING FLOW FIELD. MEASUREMENTS, INCLUDING FORCES, MOMENTS, PRESSURES, AND FLOW FIELD SCHLIEREN PHOTOGRAPHS, ARE BEING OBTAINED FOR SIMULATED EXHAUST FLOW IN ORDER TO IDENTIFY THE BASIC CHARACTER OF THE INTERACTIONS AND TO PROVIDE A SOUND BASIS FOR THEORETICAL ANALYSIS. PROPULSIVE, ATTITUDE CONTROL, AND RETRO-NOZZLE FLOWS ARE BEING INVESTIGATED. IDENTIFICATION OF NON-STEADY AS WELL AS STEADY FLOW INTERACTIONS ARE SOUGHT. THE INITIAL COLD GASEOUS N₂ SIMULATION TECHNIQUE IS BEING IMPROVED BY THE ADDITION OF A TWO GAS MIXING CAPABILITY SO THAT THE EXHAUST GAMMA CAN BE VARIED OVER A WIDE RANGE. FOR THIS, A GASEOUS SF₆ SUPPLY IS BEING PROVIDED AND CAPABILITY OF FROM 0 PERCENT TO 100 PERCENT OF EITHER GAS----

RTOP NO. 128-31-95 TITLE: HEAT TRANSFER AND FLUID FLOW
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: GREGORY, J. W. TEL. 216-433-4000
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS PROGRAM ARE TO PROVIDE IMPROVEMENTS IN THE TECHNOLOGY AND INCREASED UNDERSTANDING OF HEAT TRANSFER AND FLUID FLOW PROCESSES IN LIQUID ROCKET THRUST CHAMBERS. RELIABILITY, WEIGHT, AND PERFORMANCE AND AREAS SUBJECT TO IMPROVEMENT IN BOTH CURRENT AND FUTURE ROCKET ENGINES THROUGH A BETTER UNDERSTANDING OF SUCH PROCESSES. IN THE HEAT TRANSFER AREA, EFFORTS WILL BE DIRECTED TOWARD IMPROVING OUR ABILITY TO COOL ROCKET ENGINES IN HIGH HEAT FLUX SITUATIONS (E.G., ENGINES USING SPACE STORABLE PROPELLANTS, HYDROGEN-FLUORINE, OR HIGH PRESSURE HYDROGEN-OXYGEN), OR UNDER SPECIAL HEAT TRANSFER SITUATIONS. TRANSPIRATION, FILM, AND FORCED CONVECTIVE COOLING ARE THE PRIMARY TECHNIQUES OF INTEREST. IN THE FLUID FLOW AREA, EXPERIMENTAL AND ANALYTICAL EFFORTS WILL INCLUDE EVALUATION OF EFFECTS ON NOZZLE PERFORMANCE OF CHEMICAL DISSOCIATION PECULIAR TO HIGH ENERGY, HIGH TEMPERATURE PROPELLANTS.

RTOP NO. 128-31-95 TITLE: HEAT TRANSFER AND FLUID FLOW PROCESSES
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. J. TEL. 213-354-2546
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO ADVANCE THE STATE OF THE ART OF HEAT TRANSFER AND FLUID FLOW; SPECIFICALLY FLOW IN AND BEYOND ROCKET MOTOR NOZZLES. ONE GOAL IS TO ENHANCE THE CAPABILITY OF LIQUID ROCKET MOTOR NOZZLES AND REDUCE HEAT FLUX THROUGH THE USE OF RADICAL NOZZLE SHAPES. A BETTER QUANTITATIVE KNOWLEDGE OF BOUNDARY LAYER PHENOMENA IN NOZZLES MUST ALSO BE DEVELOPED IN ORDER TO PREDICT THE SPATIAL LOCATION OF THE BOUNDARY LAYER AFTER IT LEAVES THE NOZZLE. THE RADICAL NOZZLE APPROACH OFFERS THE POSSIBILITY OF DRASTICALLY REDUCED HEAT TRANSFER LOADS TO ROCKET ENGINE THRUST CHAMBERS AND THEREBY PERMITS THE USE OF SIMPLIFIED COOLING TECHNIQUES FOR HIGH ENERGY SPACE-STORABLE PROPELLANT SYSTEMS. THESE SAME ANALYTICAL TECHNIQUES COULD BE EXTENDED TO COVER INTERACTION OF EXHAUST JETS WITH EXTERNAL FLOW AND BODY SHAPES. ANOTHER GOAL IS THE APPLICATION OF REGENERATIVE COOLING TECHNIQUES TO THRUST CHAMBERS FOR THE SPACE-STORABLE PROPELLANTS OF O_2 AND B_2H_6 . ROCKET ENGINES CAPABLE OF SUSTAINED OPERATION FOR PERIODS OF UP TO 1000 SEC. ARE CRITICALLY NEEDED FOR SUCH POTENTIAL FUTURE APPLICATIONS AS THE SPACE-STORABLE PROPULSION MODULE (RTOP 731-12-42). THE REGENERATIVE APPROACH HAS BEEN SHOWN TO BE FEASIBLE FOR THIS PROPELLANT COMBINATION AND OFFERS HIGH PERFORMANCE, MATERIALS COMPATIBILITY, DURABILITY, AND RELIABILITY.

RTOP NO. 128-32-60 TITLE: SOLID PROPULSION SYSTEMS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: DRALEY, E. C. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS PROGRAM IS TO DEVELOP NEW AND IMPROVE EXISTING ATTRIBUTES OF CHARACTERISTICS OF SOLID/SOLID-DERIVED PROPULSION SYSTEMS AS CANDIDATES TO ACCOMPLISH PROPULSION FUNCTIONS REQUIRED FOR PROBABLE FUTURE NASA MISSIONS. THESE CHARACTERISTICS MAY BE OPERATIONAL, PHYSICAL OR INTRINSIC. MORE SPECIFIC OBJECTIVES INCLUDE (1) DEMONSTRATING AND EVALUATING A STERILIZABLE SOLID PROPULSION SYSTEM SUITABLE FOR PLANETARY EXPLORATION MISSIONS, (2) DEVELOPING AND EVALUATING METHODS FOR PROVIDING SOLID ROCKET MOTORS WITH IMPROVED CAPABILITIES TO WITHSTAND EXTENDED ENVIRONMENTS, AND (3) DEMONSTRATING IN MOTOR HARDWARE THE TECHNOLOGY NECESSARY TO PROVIDE HIGHLY RELIABLE HIGHER PERFORMANCE, LOWER COST, AND MORE VERSATILE SOLID/SOLID-DERIVED PROPULSION SYSTEMS. THE DEVELOPMENT AND DEMONSTRATION OF STERILIZABLE SOLID ROCKET MOTOR TECHNOLOGY WILL BE CONTINUED IN FY 71. AEROJET WILL ATTEMPT TO DEMONSTRATE ITS CANDIDATE PROPELLANT/LINER SYSTEM FOR THIS EXTENDED THERMAL ENVIRONMENT IN SMALL MOTOR HARDWARE IDENTICAL TO THAT USED BY UNITED TECHNOLOGY CENTER (NAS1-8937) IN A RECENT UNSUCCESSFUL PROGRAM WHICH ENCOUNTERED SEVERE TECHNICAL DIFFICULTIES. ATTEMPTS TO DATE BY OTHERS TO DEVELOP STERILIZABLE SOLID ROCKETS HAVE ALSO BEEN LARGELY UNSUCCESSFUL. THE EFFECTS OF OTHER EXTENDED ENVIRONMENTS (TIME, VACUUM, RADIATION, TEMPERATURE) LIKELY TO BE ENCOUNTERED IN FUTURE NASA MISSIONS SUCH AS SPACE SHUTTLE, SPACE STATION, AND PLANETARY

EXPLORATION MISSIONS ON THE BALLISTIC, PHYSICAL, AND CHEMICAL PROPERTIES OF TYPICAL PROPELLANTS AND REPRESENTATIVE SOLID ROCKET SYSTEMS (CASE/INSULATOR/LINER/PROPELLANT) WILL BE INVESTIGATED. ANALYTICAL AND EXPERIMENTAL STUDIES WILL BE CONDUCTED TO EVALUATE, AND IMPROVE IF NECESSARY, THE ABILITY OF SOLID ROCKETS TO ACCOMMODATE THESE ENVIRONMENTS. SEVERAL PROMISING SOLID/SOLID-DERIVED (NON-CRYOGENIC) CANDIDATE PROPULSION CONCEPTS WILL BE EXPLORED THROUGH STUDIES AND HARDWARE DEMONSTRATIONS TO DETERMINE THEIR POTENTIAL FOR INCREASED PERFORMANCE, LOWER COST, HIGHER RELIABILITY AND FLEXIBILITY.

RTOP NO. 128-32-60 TITLE: SOLID PROPULSION SYSTEMS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. J. TEL. 213-354-2546
TECHNICAL SUMMARY

THIS PROGRAM IS A BROAD BASED APPLIED RESEARCH PROGRAM TO INVESTIGATE AND EVALUATE THE INTERFACES AND ENVIRONMENTS PECULIAR TO THE LOW THRUST END BURNING CONCEPT OF SOLID PROPELLANT MOTORS. THOSE PROBLEMS OF COMPONENTS, MATERIALS, AND MOTOR PERFORMANCE WILL BE STUDIED SO THAT THE LOW THRUST LONG BURNING TIME MOTORS CAN MEET THE SPACECRAFT REQUIREMENTS FOR FUTURE NASA OUTER PLANETARY MISSIONS SUCH AS JUPITER-ORBITER. THE PROGRAM WILL BE ACCOMPLISHED THROUGH IN-HOUSE EFFORTS AND BY INDUSTRIAL CONTRACTS. COMPARISON, EVALUATION, AND DEMONSTRATION IS REQUIRED OF THE MERITS OF NEW SOLID SYSTEM COMPONENTS, WHICH MEET THE PROPULSION REQUIREMENTS FOR LONG TERM SPACE MISSIONS. THOSE PROBLEMS OF INERT COMPONENTS ASSOCIATED WITH LONG BURNING TIME (300 SEC.) LOW THRUST (1800 LBS.) MOTORS WILL BE EVALUATED. NEW AND COST-EFFECTIVE MATERIALS FOR NOZZLES, CHAMBER INSULATION, AND MOTOR INITIATORS WILL BE STUDIED TO IMPROVE FABRICATION TECHNIQUES, COMPONENT DESIGN, AND MOTOR PERFORMANCE. THE EVALUATION OF THESE COMPONENTS WILL BE ACCOMPLISHED ON THE JPL DESIGNED NON-GELLING SOLID PROPELLANT TEST MOTORS. IMPROVED COMPONENT PERFORMANCE WILL BE DEMONSTRATED ON FLIGHT-TYPE HARDWARE. ADDITIONAL KNOWLEDGE IS REQUIRED OF THE ASSOCIATED COMPLEX PROCESSES WHICH OCCUR DURING THE MANUFACTURE, STORAGE, AND FIRING OF SOLID PROPELLANT MOTORS IN THE LOW THRUST REGIONS. WORK IS BEING CONDUCTED TO SOLVE THE PROBLEMS OF LOW ACCELERATION IGNITION AND COMBUSTION INSTABILITY OF SOLID PROPELLANTS. INVESTIGATION INTO THE OXIDIZER VARIABLES WHICH CAUSE PROPELLANT INSTABILITY WILL BE CONTINUED.

RTOP NO. 128-32-61 TITLE: PYROTECHNIC SYSTEMS ENGINEERING
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: DRALEY, E. C. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO DEVELOP AND DEMONSTRATE ADVANCED PYROTECHNIC SYSTEM TECHNOLOGY FOR THE SPACE SHUTTLE AND SPACE STATION WITH MAJOR EMPHASIS ON IMPROVED RELIABILITY, COST AND PERFORMANCE. INCREASING SPACECRAFT SOPHISTICATION HAS PRODUCED DEMANDS FOR MINIMUM SIZES, BROADER SPECTRUM OF PERFORMANCE, ELIMINATION OF THE UNDESIRABLE EFFECTS OF PYROTECHNIC PERFORMANCE ON

SPACECRAFT SYSTEMS (MECHANICAL SHOCK, SMOKE, DEBRIS), AND MINIMUM REDUNDANCY. COMPOUNDING THESE REQUIREMENTS IS THE NECESSITY FOR DEMONSTRATING THE RELIABILITY OF PYROTECHNIC SYSTEMS FOR THE LONG DURATION, EXTREME ENVIRONMENTS OF THE SHUTTLE AND STATION. IMPROVED NONDESTRUCTIVE TESTING TECHNIQUES ARE REQUIRED TO IDENTIFY CRITICAL FLAWS IN PYROTECHNIC COMPONENTS. STANDARDS FOR PYROTECHNIC MATERIALS AND SYSTEMS, SPECIFICATIONS, TEST TECHNIQUES AND EQUIPMENT, AND TECHNIQUES TO ESTABLISH PERFORMANCE MARGINS AND RELIABILITY ARE NEEDED. ADVANCED PYROTECHNIC CONCEPTS WILL BE ANALYZED TO FULFILL MISSION REQUIREMENTS, SUCH AS TOTAL CONTAINMENT OF ALL COMBUSTION PRODUCTS AND SHRAPNEL, AND REUSEABILITY.

RTOP NO. 128-32-70 TITLE: COMPONENTS, MATERIALS, AND SUBSYSTEMS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: WEEKS, P. J. TEL. 213-354-2546
TECHNICAL SUMMARY

THIS IS AN APPLIED RESEARCH PROGRAM DESIGNED TO PROVIDE THE PYROTECHNIC SYSTEM TECHNOLOGY REQUIRED FOR FUTURE PLANETARY MISSIONS. AREAS OF INVESTIGATION INCLUDE NEW INITIATOR AND DEVICE CONCEPTS, EVALUATION OF THE EFFECTS OF NEW ENVIRONMENTS ON PYROTECHNIC SYSTEMS, IMPROVED ANALYTICAL METHODS FOR INITIATOR AND DEVICE DESIGN AND EXPERIMENTAL DETERMINATION OF EXPLOSIVE COMPOUND CHARACTERISTICS WHICH ARE UTILIZED IN PYROTECHNIC SYSTEMS. THIS EFFORT IS TO BE CONDUCTED THROUGH IN-HOUSE AND CONTRACTED EFFORTS BY INDUSTRIAL AND GOVERNMENT RESEARCH PERSONNEL.

RTOP NO. 128-32-70 TITLE: COMPONENTS, MATERIALS AND SUBSYSTEMS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: DRALEY, E. C. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO INVESTIGATE AND DEMONSTRATE COMPONENTS, MATERIALS, AND SUBSYSTEMS HAVING THE POTENTIAL FOR IMPROVED RELIABILITY, COST EFFECTIVENESS, AND PERFORMANCE FOR SOLID OR SOLID-DERIVED PROPULSION SYSTEMS. THIS PROGRAM INCLUDES (1) RESEARCH ON MATERIALS FOR ROCKET MOTOR COMPONENTS AND PYROTECHNICS (NOZZLES FOR ENERGETIC SOLIDS AND HYBRIDS, ENVIRONMENTAL EFFECTS ON PYROTECHNIC MATERIALS, AND CONCEPTS AND MATERIALS FOR MOLDED SOUNDING ROCKET COMPONENTS), (2) DEMONSTRATION OF THESE AS COMPONENTS AND SUBSYSTEMS, AND (3) DETERMINATION AND IMPROVEMENT OF COMPONENT RELIABILITY (INVOLVING IMPROVEMENT IN NONDESTRUCTIVE TESTING (NDT) THROUGH ADVANCED TECHNIQUES AND INVESTIGATION OF THE SEVERITY OF ROCKET MOTOR DEFECTS). SATISFACTORY NOZZLE SYSTEMS ACCOMMODATING COMBUSTION TEMPERATURES TO 8500 DEGREES F AT HIGH PRESSURES FOR HIGHLY ENERGETIC SOLIDS AND HYBRIDS DO NOT CURRENTLY EXIST AND MUST BE DEVELOPED. THE NOZZLE INVESTIGATION WILL CENTER PRIMARILY ON SURVIVABILITY THROUGH ACTIVE COOLING TECHNIQUES - MASS INJECTION INTO THE BOUNDARY LAYER. SEVERAL PROMISING CONCEPTS WILL BE EVALUATED. DEMONSTRATION OF A NOZZLE SUITABLE FOR HYBRID ROCKET APPLICATIONS BY FY 72 IS ANTICIPATED. WITH THE EXTENDED DURATION OF FUTURE NASA MISSIONS SUCH AS SPACE SHUTTLE, SPACE STATION, AND LUNAR AND

PLANETARY EXPLORATION INVOLVING MORE SEVERE ENVIRONMENTAL CONDITIONS AND INCREASED RELIABILITY REQUIREMENTS, THERE IS A NEED FOR BETTER UNDERSTANDING OF THE TECHNOLOGY GOVERNING THE LIFE AND PERFORMANCE MECHANISMS OF IGNITERS/ELECTROEXPLOSIVE DEVICES. FUNDAMENTAL STUDIES OF EFFECT OF AGING, EXTENDED ENVIRONMENTAL CONDITIONS, ETC., ON DESIGN, MATERIALS, PERFORMANCE, AND OPERATIONAL CHARACTERISTICS WILL BE CONDUCTED. THE POTENTIAL COST REDUCTIONS WHICH CAN BE OBTAINED FROM THE APPLICATION OF----

RTOP NO. 128-32-80 TITLE: SOLID PROPELLANT TECHNOLOGY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. TEL. 213-354-2546
TECHNICAL SUMMARY

THE TWO OBJECTIVES OF THIS PLAN ARE DIRECTED TOWARD THE DEVELOPMENT OF TECHNOLOGY TO MEET THE REQUIREMENTS OF FUTURE SPACECRAFT MISSIONS. CURRENT REQUIREMENTS ARE TO PROVIDE HIGH-PERFORMANCE, LOW-ACCELERATION SOLID PROPELLANT ROCKET MOTORS FOR PROPULSION OF FULLY DEPLOYED SPACECRAFT (E.G., ORBIT INSERTION OF THE PLANET, JUPITER). OBJECTIVE NUMBER (1) DEALS WITH PROPELLANT DEVELOPMENT, AND OBJECTIVE NUMBER (2) WITH MECHANICAL BEHAVIOR. (1) PROPELLANT DEVELOPMENT INCLUDES PROJECTS WITH SHORT TERM AND LONG TERM GOALS. GOALS IN THE SHORT-TERM CATEGORY INCLUDE THE DEVELOPMENT (WITH STATE-OF-THE-ART PROPELLANT SYSTEMS) OF LOW BURNING RATE WITHOUT LOSS IN PERFORMANCE AND OF LOW-MODULUS FORMULATIONS SUITABLE FOR USE IN THE CASE-BONDED END-BURNER CONFIGURATION. THESE TWO CHARACTERISTICS ARE FOR THE PURPOSE OF PRODUCING LOW-THRUST MOTORS FOR LOW ACCELERATION. A FURTHER SHORT-TERM GOAL IS THE EXTENSION OF PROPELLANT TIME AND TEMPERATURE STORAGE CAPABILITIES TO UP-GRADE RELIABILITY DURING LONG SPACE TRIPS. THE CHIEF LONG-TERM GOAL IS TO INCREASE PROPULSION PERFORMANCE OF SUCH PROPELLANTS AROUND 10 PER CENT BY USING BERYLLIUM. (2) MECHANICAL BEHAVIOR STUDIES ARE ALSO ORIENTED TO LONG TERM GOALS AND SHORT TERM OBJECTIVES. THE LONG TERM GOALS ARE TO DEVELOP AN OMNIBUS THEORY OF VISCOELASTIC BEHAVIOR, BY WHICH A KNOWLEDGE OF BASIC MOLECULAR PARAMETERS WILL PERMIT THE PREDICTION OF PROPELLANT MATERIAL RESPONSE IN A GENERALIZED STRESS-TIME-TEMPERATURE FIELD; AND TO INTEGRATE THIS THEORY WITH A COMPREHENSIVE STRESS ANALYSIS PROGRAM TO CREATE, TOGETHER WITH THE PROPELLANT DEVELOPMENT ACTIVITIES, A RELIABLE MOTOR-ORIENTED TECHNOLOGY BASE. IN THE SHORT TERM, MORE DEFINITE KNOWLEDGE IS SOUGHT OF FINITE DEFORMATION, RUPTURE AS A FRACTION OF MOLECULAR PARAMETERS AND IN A MACROSCOPIC CONTEXT, BINDER-FILLER INTERACTIONS, MATERIAL CHARACTERIZATION IN ENGINEERING TERMS, STRESS ANALYSIS USING LINEAR AND NON-LINEAR VISCOELASTIC MODELS, AND ENGINEERING FAILURE CRITERIA. BECAUSE THESE STUDIES INTERACT WITH QUALITY ASSURANCE, RESEARCH AND DEVELOPMENT OF NONDESTRUCTIVE TESTING TECHNIQUES WHICH ARE SUITED TO SOLID PROPULSION MOTORS SYSTEMS AND WHICH ARE IN THE VANGUARD OF THE STATE-OF-THE-ART WILL BE UNDERTAKEN.

RTOP NO. 128-32-86 TITLE: PROPELLANT MECHANICAL BEHAVIOR
ORGANIZATION: JET PROPULSION LAB
MONITOR: MEEKS, P. TEL. 213-354-2546
TECHNICAL SUMMARY

THE MAJOR GOAL OF THE PROPELLANT MECHANICAL BEHAVIOR PROGRAM IS TO PROVIDE AN UNDERSTANDING OF SOLID PROPELLANT GRAIN RESPONSE OVER THE DUTY CYCLE EXPERIENCED BY MOTORS IN SPACECRAFT APPLICATION, TO ACHIEVE A MAXIMUM LEVEL OF CONFIDENCE IN THE RELIABILITY OF THE GRAIN STRUCTURAL INTEGRITY. TO ATTAIN THIS GOAL, MECHANICAL BEHAVIOR STUDIES ARE ORIENTED TO LONG TERM AND SHORT TERM OBJECTIVES. THE LONG TERM OBJECTIVES ARE TO DEVELOP AN OMNIBUS THEORY OF VISCOELASTIC BEHAVIOR BY WHICH A KNOWLEDGE OF BASIC MOLECULAR PARAMETERS WILL PERMIT THE PREDICTION OF PROPELLANT MATERIAL RESPONSE IN A GENERALIZED STRESS-TIME-TEMPERATURE FIELD; AND TO INTEGRATE THIS THEORY WITH A COMPREHENSIVE STRESS ANALYSIS PROGRAM TO CREATE TOGETHER WITH THE PROPELLANT DEVELOPMENT ACTIVITIES, A RELIABLE MOTOR-ORIENTED TECHNOLOGY BASE. IN THE SHORT TERM MORE DEFINITE KNOWLEDGE IS SOUGHT ON FINITE REFORMATION, RUPTURE AS A FUNCTION OF MOLECULAR PARAMETERS IN ENGINEERING TERMS, STRESS ANALYSIS USING LINEAR AND NONLINEAR VISCOELASTIC MODELS, AND ENGINEERING FAILURE CRITERIA. BECAUSE THESE STUDIES INTERACT WITH QUALITY ASSURANCE, RESEARCH AND DEVELOPMENT OF NONDESTRUCTIVE TESTING TECHNIQUES WHICH ARE SUITED TO SOLID PROPELLANT MOTORS SYSTEMS AND WHICH ARE IN THE VANGUARD OF THE STATE-OF-THE-ART WILL BE UNDERTAKEN.

RTOP NO. 128-32-90 TITLE: SOLID PROPULSION COMBUSTION AND KINETICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: DRALEY, E. C. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IN SOLID PROPULSION COMBUSTION AND KINETICS IS TO ACQUIRE PERTINENT EXPERIMENTAL KNOWLEDGE AND UNDERSTANDING OF (1) CONDENSED-PHASE REACTION AND GASIFICATION MECHANISMS OF AMMONIUM PERCHLORATE-BASED COMPOSITE PROPELLANTS, (2) DOMINANT GAS-PHASE REACTION AND HEAT/MASS TRANSFER MECHANISMS JUST ABOVE BURNING PROPELLANT SURFACES, AND (3) THE GASDYNAMICS AND BALLISTICS OF CERTAIN ROCKET CHAMBERS. SPECIFIC CONTRACTED AND IN-HOUSE PROGRAM PLANS COVER RESEARCH IN THE FOLLOWING AREAS: EFFECTS OF CONDENSED-PHASE REACTIONS ON PROPELLANT COMBUSTION, CO₂ LASER PYROLYSIS - MASS SPECTROMETRY OF PROPELLANT INGREDIENTS, AMMONIUM PERCHLORATE/PROPELLANT STABILIZATION, PROPELLANT FLAME STUDIES, METAL COMBUSTION, ACCELERATION-INDUCED PROPELLANT COMBUSTION EFFECTS, SOLID PROPELLANT INSTANTANEOUS BURNING RATE MEASUREMENTS, DEPRESSURIZATION EXTINCTION OF SOLID PROPELLANTS, WATER QUENCH EXTINCTION, AND IGNITION OF SOLID ROCKETS.

RTOP NO. 128-32-90 TITLE: SOLID PROPULSION COMBUSTION AND KINETICS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. TEL. 213-354-2546
TECHNICAL SUMMARY

THE OBJECTIVE OF BERYLLIUM PARTICLE COMBUSTION STUDIES IS TO

UNDERSTAND THE MECHANISM SO THAT IMPROVED COMBUSTION EFFICIENCY CAN BE OBTAINED AT LOW CHAMBER PRESSURES. THE STUDY OF THE CHEMISTRY OF THE COMBUSTION PROCESS IS TO LEAD TOWARD MORE KNOWLEDGE ABOUT HOW PROPELLANTS SHOULD BE FORMULATED TO IMPROVE THEIR STEADY STATE AND TRANSIENT COMBUSTION CHARACTERISTICS. THE APPROACH FOR METAL COMBUSTION IS TO USE SPECIAL LABORATORY EQUIPMENT SUCH AS HOT STAGE MICROSCOPE, SCANNING ELECTRON MICROSCOPE, TO OBSERVE HOW METAL PARTICLES MELT, AGGLOMERATE, IGNITE AND BURN. A RAPID SCANNING SPECTROMETER IS USED TO STEADY THE CHEMICAL SPECIES WHICH ARE RESOLVED IN TIME AND SPACE DURING THE COMBUSTION PROCESS.

RTOP NO. 129-01-20 TITLE: AERO-FLUID DYNAMICS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

SEVERAL AREAS OF WORK WILL BE COVERED UNDER THIS RTOP. AERO FLUID DYNAMICS PROBLEMS BY APPLICATION OF THE VORTEX-MODEL OF TURBULENCE-ELEMENTS, AN INVESTIGATION OF THE SCALE EFFECTS OF SENSOR DIMENSIONS ON THE VELOCITY-DISTRIBUTIONS WITH WIDELY VARYING EDDY-SIZES WILL BE DONE. FLUID PHYSICS RELATED WORK WILL BE DONE BY MONITORING THE DISPERSION OF HEAT AND HUMIDITY WITH BOTH ELECTROMAGNETIC AND HOT WIRE SENSORS. BASIC FLUID PHYSICS PROCESSES RESULTING IN NOISE CREATED BY HIGH SPEED AERODYNAMIC FLOWS WILL BE STUDIED.

RTOP NO. 129-01-20 TITLE: AERONAUTICAL FLUID DYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO ACQUIRE AN UNDERSTANDING OF THE BASIC FLUID DYNAMIC MECHANISMS AND CONTROLLING PHYSICAL PARAMETERS IN PROBLEMS RELEVANT TO AERONAUTICS. SPECIFICALLY, THIS WORK WILL COVER HYPERSONIC TURBULENT BOUNDARY LAYERS (HEAT TRANSFER, TRANSITION, SEPARATION, MASS ADDITION), AND MECHANISMS SUCH AS PHOTOCHEMICAL AND GAS KINETIC THAT LEAD TO THE FORMATION OF AIR POLLUTANTS. THIS WORK WILL BE UNDERTAKEN THROUGH A COMBINATION OF PHYSICAL SIMULATION (WIND TUNNEL TESTING), ANALYTICAL SIMULATION (COMPUTER SOLUTIONS), AND THEORETICAL ANALYSIS. RESULTS WILL BE APPLICABLE TO ADVANCED AERONAUTICAL SYSTEMS AND PROVIDE NECESSARY INPUTS FOR DEVELOPING IMPROVED AIRCRAFT.

RTOP NO. 129-01-20 TITLE: AERONAUTICAL FLUID DYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THIS EFFORT WILL GIVE AN UNDERSTANDING OF BASIC FLUID DYNAMIC MECHANISMS AND CONTROLLING PHYSICAL PARAMETERS IN BASIC PROBLEMS RELEVANT TO AERODYNAMICS. BOTH THEORETICAL AND EXPERIMENTAL STUDIES ARE EMPLOYED AND THE EFFORT FOR THE PRESENT FISCAL YEAR CAN BE CHARACTERIZED BY THE FOLLOWING ACTIVITIES. STUDIES OF SEPARATION AND THREE-DIMENSIONAL BOUNDARY LAYER FLOWS, TURBULENT BOUNDARY LAYERS, MASS-TRANSFER EFFECTS ON BOUNDARY-LAYER FLOWS, BOUNDARY-LAYER TRANSITION, THE PREDICTION OF FLOW FIELDS ABOUT CONFIGURATIONS, AND HYPERSONIC WIND TUNNEL DEVELOPMENT. THE INFORMATION DEVELOPED WILL ALLOW MORE RATIONAL PREDICTION OF CONTROL FORCES, HEAT TRANSFER, AND SKIN FRICTION ON AIRCRAFT.

RTOP NO. 129-01-20 TITLE: AERONAUTICAL FLUID DYNAMICS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS PROGRAM ARE THE STUDY OF FUNDAMENTAL FLUID DYNAMIC AND CHEMICAL MECHANISMS THAT OCCUR IN AERONAUTICS AND IN THE ATMOSPHERE. EMPHASIS IS CENTERED ON THE STABILITY OF THE LAMINAR BOUNDARY LAYER IN SUPERSONIC FLOW AND ON THE PHOTOCHEMICAL PROCESSES OF AIR POLLUTION. BOUNDARY LAYER STABILITY STUDIES ARE EFFECTED BY CLOSELY COORDINATED THEORY AND EXPERIMENT. THE PRESENT PROGRAM RELIES HEAVILY ON THE UNIQUE PERFORMANCE OF THE JPL WIND TUNNELS. THE BOUNDARY LAYER RESPONSE TO EXTERNALLY IMPOSED DISTURBANCES IS BEING STUDIED BOTH EXPERIMENTALLY AND THEORETICALLY WITH A VIEW TOWARD GAINING INSIGHT INTO THE RELATION BETWEEN WIND-TUNNEL AND FREE-FLIGHT OBSERVATIONS OF TRANSITION. THE CHEMICAL PROCESSES INVOLVED IN AIR POLLUTION ARE BEING STUDIED WITH A VIEW TOWARD THE ESTABLISHMENT OF THE ROLES OF VARIOUS POLLUTANTS IN THE OVERALL PHOTOCHEMICAL CHAIN. THE KNOWLEDGE OF KEY CHEMICAL MECHANISMS IS ABSOLUTELY NECESSARY TO THE UNDERSTANDING AND RATIONAL CONTROL OF POLLUTION PROCESSES. STUDIES OF THE REACTIONS OF ATOMIC OXYGEN AND OZONE ARE CARRIED OUT USING PHOTOCHEMICAL TECHNIQUES PIONEERED AT THIS LABORATORY.

RTOP NO. 129-01-20 TITLE: AERONAUTICAL FLUID DYNAMICS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: DEISSLER, R. G. TEL. 216-433-4000
TECHNICAL SUMMARY

THE INTERACTION OF JETS WITH SOLID BOUNDARIES OR WITH OTHER JETS OR FLOWS OCCURS IN VTOL AIRCRAFT, JET INJECTION INTO COMBUSTION CHAMBERS, JET FLAPS, NOZZLE FILM COOLING AND OTHER AERODYNAMIC APPLICATIONS. THE FLOW PATTERNS CAN BE QUITE COMPLICATED EVEN FOR THE INVISCID CASE SINCE THE FREE STREAMLINES BOUNDING THE FLOW REGIONS MUST BE FOUND. FURTHER COMPLICATIONS ARE INTRODUCED BY FRICTION AND ENTRAINMENT EFFECTS AS WELL AS THE THREE DIMENSIONAL

NATURE OF THE FLOW. ANALYTICAL STUDIES ARE BEING MADE TO AID IN THE PREDICTION OF JET FLOW BEHAVIOR. NOISE RESEARCH: THE BASIC FLUID MECHANICS OF EXHAUST JET NOISE WILL BE STUDIED ANALYTICALLY AND EXPERIMENTALLY. THIS WILL BE DONE FOR BOTH SUBSONIC AND SUPERSONIC JETS TO BETTER REVEAL THE NOISE PRODUCING MECHANISMS. THE PERCEPTION OF SOUND WILL BE STUDIED IN TERMS OF THE RESPONSE OF THE HUMAN HEARING SYSTEM TO AN INCIDENT PRESSURE WAVEFORM. A SONIC BOOM OR NOISE PRODUCING DEVICE PRODUCES A PRESSURE SIGNAL. THE PRESSURE SIGNAL MUST THEN BE EVALUATED IN TERMS OF HUMAN RESPONSE IN ORDER TO DETERMINE THE LOUDNESS OR NOISE THAT WILL ACTUALLY BE PERCEIVED. A TRANSFER FUNCTION OF THE HUMAN AUDITORY SYSTEM HAS BEEN FORMULATED. IT WILL BE APPLIED TO VARIOUS SONIC BOOM PRESSURE WAVES AND NOISE SOURCES SO THAT THE PSYCHOLOGICAL RESPONSE CAN BE EVALUATED.

RTOP NO. 129-01-20 TITLE: AERONAUTICAL FLUID DYNAMICS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: SCHWARTZ, I. R. TEL. 202-962-0171
TECHNICAL SUMMARY

THEORETICAL AND EXPERIMENTAL STUDIES ARE TO BE EMPLOYED TO ACQUIRE AN UNDERSTANDING OF THE BASIC FLUID DYNAMIC MECHANISMS AND CONTROLLING PHYSICAL PARAMETERS IN PROBLEMS RELEVANT TO AERONAUTICS. THIS RESEARCH WILL BE PERFORMED IN THE AREAS OF: EXTERNAL FLOW FIELDS SUCH AS COMPRESSIBLE TURBULENT BOUNDARY LAYERS INCLUDING HEAT TRANSFER EFFECTS, FLOW SEPARATION, THREE DIMENSIONAL FLOW, MASS TRANSFER, AND THE INFLUENCE OF FREE STREAM DISTURBANCES ON BOUNDARY LAYER STABILITY AND TRANSITION; AIRCRAFT ENVIRONMENT INCLUDING CLEAR AIR TURBULENCE AND GROUND FOG; ENVIRONMENTAL POLLUTION INCLUDING SONIC BOOM GENERATION, PROPAGATION AND REDUCTION, AERODYNAMIC NOISE GENERATION, PROPAGATION FROM ENGINE EXHAUST JETS AND ROTATING MACHINERY (COMPRESSORS AND TURBINES) AND NOISE PREDICTION AND MINIMIZATION, AND CHEMICAL AND SMOKE POLLUTION FROM ENGINES. THIS RESEARCH CONTRIBUTES TO PRESENT AND FUTURE AIRCRAFT DEVELOPMENT PROGRAMS.

RTOP NO. 129-01-21 TITLE: INTERNAL FLUID DYNAMICS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: SCHWARTZ, I. R. TEL. 202-962-0171
TECHNICAL SUMMARY

EXPERIMENTAL AND THEORETICAL STUDIES ARE TO BE CONDUCTED TO ACHIEVE A BASIC UNDERSTANDING OF THE FLUID FLOW AND HEAT AND MASS TRANSFER IN INTERNAL AND DUCTED CONFIGURATIONS. THE EFFORT WILL LOOK FAR AHEAD AND IDENTIFY AND STUDY FLUID DYNAMIC PROBLEMS THAT MUST BE SOLVED TO ALLOW MAJOR ADVANCES IN TECHNOLOGY. THIS RESEARCH WILL INCLUDE THE FOLLOWING AREAS: A. FLOWS IN INLETS, DUCTS, ROTATING MACHINERY. STUDIES OF BOUNDARY LAYERS IN INLETS WITH CENTERBODIES; EFFECTS OF ADVERSE PRESSURE GRADIENTS AND TURBULENCE; CHEMICAL KINETICS OF COMBUSTION AND THE EXPANSION OF PROPULSION GASES THROUGH NOZZLES; INVESTIGATION OF VORTEX FLOWS; FLOW IN ROTATING MACHINERY - INTERFERENCE EFFECTS, FLOW INTERACTION. EMPHASIS ON FLUID DYNAMIC PROBLEMS OF SUPERSONIC COMPRESSORS; STUDY THE BEHAVIOR OF THE

TURBULENT BOUNDARY LAYER IN THE RANGE OF REYNOLDS NUMBERS AND STAGNATION TEMPERATURE REGIME RELEVANT TO HYPERSONIC INLETS -TESTING OF NEW THEORETICAL MODELS. INVESTIGATION OF VARIOUS CONCEPTS FOR HIGHER REYNOLDS NUMBER TRANSONIC TUNNELS. B. HEAT TRANSFER PROBLEMS IN INTERNAL FLOW. STUDIES OF HEAT TRANSFER IN COMPRESSIBLE TURBULENT BOUNDARY LAYER FLOWS - TESTING NEW THEORETICAL MODELS FOR SUPERSONIC AND HYPERSONIC FLOW REGIMES; INVESTIGATIONS OF THE DISTRIBUTION OF HEATING IN SHOCK-BOUNDARY LAYER INTERACTIONS; INFLUENCE OF SEPARATION AND REATTACHMENT;----

RTOP NO. 129-01-21 TITLE: INTERNAL FLUID DYNAMICS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: GRAHAM, R. W. TEL. 216-433-4000
TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE THE KNOWLEDGE NEEDED TO PREDICT AND CONTROL THE BEHAVIOR OF BOTH HOT GASEOUS WORKING FLUIDS AND COOLING FLUIDS IN ENERGY-TRANSFER SYSTEMS. THE WORK INCLUDES EFFORTS IN FOUR DISTINCT RESEARCH AREAS, WHICH WILL BE DESCRIBED SEPARATELY: THERMODYNAMICS, TRANSPORT PROPERTIES, HEAT TRANSFER, AND CHEMICAL KINETICS. ALTHOUGH THESE AREAS ARE DISTINCT, THE WORK IS RELATED IN THAT IT IS ORGANIZED AROUND PROBLEMS IN SUCH ENERGY TRANSFER SYSTEMS AS PROPULSION AND POWER-GENERATION DEVICES, AND REACTORS FOR THE CONTROL OF POLLUTANTS IN THE EXHAUST FROM RECIPROCATING ENGINES. WITH THE EXCEPTION OF ACTUAL EXHAUST-GAS REACTORS, FULL-SCALE SYSTEMS ARE NOT STUDIED. THE APPROACH IS RATHER TO STUDY PROPERTIES AND PROCESSES APPLICABLE TO THE WHOLE CLASS OF ENERGY-TRANSFER SYSTEMS. THEORETICAL MODELS OF A PROCESS (E.G., TURBULENT HEAT TRANSFER OR FREEZING IN A FLOWING LIQUID) ARE DEVELOPED AND TESTED BY EXPERIMENT. EXPERIMENTAL MEASUREMENTS ARE MADE OF PROPERTIES (E.G., REACTION RATES OR DIFFUSION COEFFICIENTS) AND THE VALUES ARE USED IN ANALYZING THE BEHAVIOR OF ENERGY-TRANSFER SYSTEMS.

RTOP NO. 129-01-21 TITLE: INTERNAL FLUID DYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

HUMAN BLOOD FLOW AND OTHER BIOMEDICAL PHENOMENA AMENABLE TO FLUID DYNAMIC ANALYSIS ARE BEING STUDIED TO GAIN A BASIC UNDERSTANDING OF THESE PHENOMENA WHICH WILL LEAD TO IMPROVED DIAGNOSTIC AIDS FOR PREDICTING AND MONITORING THE HEALTH AND PERFORMANCE OF ASTRONAUTS.

RTOP NO. 129-01-21 TITLE: INTERNAL FLUID DYNAMICS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE GENERAL OBJECTIVE OF THIS RTOP IS TO ACHIEVE A BASIC UNDERSTANDING OF THE FLUID FLOW AND HEAT AND MASS TRANSFER IN

INTERNAL AND DUCTED CONFIGURATIONS. INCLUDED IS (1) THE DEVELOPMENT AND REFINEMENT OF PREDICTION METHODS AND (2) THE CORRELATION OF EXPERIMENTAL RESULTS FOR CONVENIENT PRACTICAL USE AND COMPARISON WITH THEORY. THIS GENERAL INVESTIGATION CONSISTS OF A STUDY OF THE FLUID DYNAMICS AND HEAT TRANSFER OF SHOCK WAVE INTERACTIONS WITH TURBULENT BOUNDARY LAYER FLOWS IN THE REYNOLDS NUMBER AND STAGNATION TEMPERATURE REGIME RELEVANT TO HYPERSONIC INLETS. THE INVESTIGATION WAS INITIATED BECAUSE THE HEAT TRANSFER RATES IN THE INLET AND COMBUSTOR REGIONS OF HYPERSONIC VEHICLES CAN BE SUFFICIENTLY HIGH TO REQUIRE SIGNIFICANT COOLING. TEMPERATURE AND PRESSURE DISTRIBUTIONS ACROSS THE BOUNDARY LAYER OF HEATED AIR FLOW IN THE VICINITY OF INCIDENT AND REFLECTED SHOCK WAVES WILL BE OBTAINED WITH SMALL PROBES. LONGITUDINAL HEAT TRANSFER DISTRIBUTIONS ALONG THE WALL OF DUCTED CONFIGURATIONS WILL ALSO BE DETERMINED.

RTOP NO. 129-01-22 TITLE: PHYSICAL GAS DYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO ACQUIRE A BASIC PHENOMONOLOGICAL UNDERSTANDING OF FLUID BEHAVIOR IN WHICH MOLECULAR, ATOMIC AND IONIC PROCESSES PLAY A SIGNIFICANT OR CONTROLLING ROLE. IN GENERAL THIS WORK WILL FOCUS ON PROBLEMS TO BE FACED BY FUTURE MISSIONS AND FOR WHICH A BASIC UNDERSTANDING WILL HAVE A LONG TERM BENEFIT TO NASA. SPECIFICALLY THIS WORK WILL BE CONCERNED WITH GAS DYNAMIC LASERS, KINETICS OF REACTING GASES, VERY HIGH TEMPERATURE GAS TRANSPORT PROPERTIES, RADIATIVE HEAT TRANSFER, RADIATIVE PROPERTIES OF GASES, EQUILIBRIUM AND NONEQUILIBRIUM FLOW FIELDS, BOUNDARY LAYER PHENOMENA SUCH AS BOUNDARY LAYER-ABLATION VAPOR INTERACTIONS AND RAREFIED GAS DYNAMICS. THE WORK WILL CONSIST OF BOTH ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS USING SHOCK TUBES, FREE FLIGHT RANGES, WIND TUNNELS, ARC JETS AND COMPUTER FACILITIES. THE RESULTS WILL FIND APPLICATION IN SUCH AREAS AS PREDICTION OF CONVECTIVE AND RADIATIVE HEATING TO BE ENCOUNTERED ON MISSIONS TO VENUS, JUPITER AND HIGH SPEED RETURN TO EARTH, ANALYSIS OF THE BEHAVIOR OF LASER HEATING SYSTEMS AND LASER COMMUNICATION SYSTEMS, ISOTOPE SEPARATION SYSTEMS, CERTAIN MILITARY SYSTEMS AS WELL AS NEW UNFORESEEN AREAS.

RTOP NO. 129-01-22 TITLE: PHYSICAL GAS DYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE IS TO OBTAIN A BASIC UNDERSTANDING OF MANY VARIED ASPECTS OF HIGH ENERGY FLUID FLOWS THROUGH THE APPLICATION OF BOTH ANALYTICAL AND EXPERIMENTAL APPROACHES. THIS WORK WILL BE CONDUCTED PRINCIPALLY IN-HOUSE WITH SOME CONTRACT SUPPORT. REAL GAS EFFECTS, RESULTING FROM THE INTERACTION OF A SPACE VEHICLE AND A PLANETARY ATMOSPHERE, SUCH AS HOT GAS RADIATION HEATING, GAS CHEMICAL KINETICS, HEAT TRANSFER, RADIO BLACK-OUT, ETC. WILL BE INVESTIGATED. EFFORT WILL ALSO BE APPLIED TO THE DEVELOPMENT OF HIGH ENTHALPY

FACILITIES AND LOW PRESSURE INSTRUMENTATION AS WELL AS TO SPECIFIC STUDIES OF GAS-DYNAMIC LASERS, PARTICLE-SURFACE INTERACTIONS, COMBUSTION PROCESSES, ETC. THE RESULTS OF THESE STUDIES WILL INCREASE THE CAPABILITY TO PREDICT THE FLOW ABOUT AN ENTRY VEHICLE INCLUDING DRAG, HEATING, MASS LOSS, RADIO TRANSMISSION, ETC. HIGH ENERGY FACILITIES DEVELOPED WILL BE APPLIED TO STUDY SOME OF THE AFOREMENTIONED EFFECTS.

RTOP NO. 129-01-22 TITLE: PHYSICAL GAS DYNAMICS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: SCHWARTZ, I. R. TEL. 202-962-0171
TECHNICAL SUMMARY

THEORETICAL AND EXPERIMENTAL STUDIES ARE TO BE CONDUCTED TO ACQUIRE A BASIC PHENOMENOLOGICAL UNDERSTANDING OF FLOWS IN WHICH MOLECULAR, ATOMIC AND IONIC PROCESSES - AS SUCH - PLAY A SIGNIFICANT OR CONTROLLING ROLE. THE INTENT IS TO IDENTIFY THE SIGNIFICANT PHYSICAL ASPECTS OF PROBLEMS RELEVANT TO THE NEEDS OF NASA AND FOCUS THE RESEARCH EFFORT ON THESE. RESEARCH IS TO BE PERFORMED IN THE AREAS OF: GAS DYNAMIC LASERS INCLUDING CONTINUED RESEARCH ON CONTINUOUS - WAVE CHEMICAL LASERS, GAS DYNAMIC MIXING BEHIND SHOCK WAVES, MOLECULAR EXPANSION LASER, AND MPD ARC LASER; FLOW OVER ABLATING ENTRY OBJECTS - INFLUENCE OF MASS TRANSFER ON LAMINAR AND TURBULENT HEAT TRANSFER INCLUDING THREE DIMENSIONAL EFFECTS, CHEMICAL NON-EQUILIBRIUM, AND BOUNDARY LAYER TRANSITION; KINETICS OF REACTING GASES; TRANSPORT PHENOMENA IN MULTICOMPONENT PARTIALLY IONIZED GASES; ELECTRICAL FLUID PHENOMENA - ELECTROHYDRODYNAMICS; RAREFIED GAS DYNAMICS INCLUDING MOLECULAR BEAM SURFACE INTERACTION EXPERIMENTS, FLOW FIELD ANALYSIS, SHOCK STRUCTURE ANALYSIS. THIS RESEARCH IS APPLICABLE TO PLANETARY ENTRY, AND PREDICTING PERFORMANCE FOR ADVANCED AIRCRAFT SUCH AS HYPERSONIC AIRCRAFT, AEROSPACE PLANES, RECOVERABLE BOOSTERS, AND ORBITING SATELLITES.

RTOP NO. 129-02-20 TITLE: QUANTUM ELECTRONICS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: JOHNSON, P. S. TEL. 202-962-6351
TECHNICAL SUMMARY

TO CARRY OUT UNIQUE FUNDAMENTAL THEORETICAL AND EXPERIMENTAL RESEARCH IN THE PHYSICS OF QUANTUM ELECTRONICS; LASERS, MASERS, AND RELATED DEVICES. THIS RESEARCH, WHICH FILLS GAPS IN THE CENTERS' WORK, IS BEING CARRIED OUT UNDER A NUMBER OF UNIVERSITY GRANTS, EACH HAVING FOR PRINCIPAL INVESTIGATOR A SCIENTIST WITH A RECORD OF OUTSTANDING ACHIEVEMENT IN ORIGINAL RESEARCH IN THIS FIELD. THESE INVESTIGATORS ARE ALSO AVAILABLE FOR CONSULTATION BY CENTER SCIENTISTS AND ENGINEERS. THE PURPOSE IS TO PROVIDE THE FUNDAMENTAL KNOWLEDGE NECESSARY FOR THE ADVANCEMENT OF OPTICAL TECHNOLOGY WHICH CAN UTILIZE COHERENT RADIATION IN ELECTRONIC COMMUNICATIONS, DISPLAY DEVICES, COMPUTERS AND GENERAL MEASUREMENTS INSTRUMENTATION TO BE APPLIED IN PLANETARY EXPLORATION, SPACE PHYSICS, AND AVIONICS. SUBJECTS TO BE INVESTIGATED INCLUDE SPECTROSCOPY, LIGHT SCATTERING, AND OPTICAL STUDIES OF CRYSTALLINE, AMORPHOUS AND LIGHT

SEMICONDUCTORS, OTHER CRYSTALLINE SOLIDS AND OTHER SUBSTANCES FOR LASERS.

RTOP NO. 129-02-20 TITLE: QUANTUM ELECTRONICS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

THE GENERAL OBJECTIVE OF THIS RTOP IS TO CONDUCT EXPERIMENTS AND ANALYSES OF SPECIFIC TOPICS IN THE PHYSICS OF QUANTUM ELECTRONICS WITH THE VIEW OF DETERMINING THOSE ASPECTS OF COHERENT EM RADIATION PARTICULARLY APPLICABLE TO SPACE SCIENCE AND/OR TECHNOLOGY. SPECIFICALLY, THE WORK WILL BE CONCERNED WITH QUANTITATIVE EVALUATIONS OF THE PHYSICAL PROCESSES THAT TAKE PLACE DURING THE GENERATION OF THE EM RADIATION WITHIN LASERS AND MASERS, DURING THE TRANSMISSION OF THIS RADIATION THROUGH THE MEDIA OF NATURAL ENVIRONMENTS OR THROUGH MAN-MADE DEVICES, AND IN THE DETECTION OF THIS RADIATION. THE PURPOSE OF THE PROGRAM IS TO PROVIDE THE FUNDAMENTAL KNOWLEDGE NECESSARY FOR THE DEVELOPMENT OF AN OPTICAL TECHNOLOGY WHICH CAN UTILIZE COHERENT RADIATION IN COMMUNICATIONS, POWER TRANSMISSION, DISPLAY DEVICES, AND GENERAL MEASUREMENT INSTRUMENTATION TO BE APPLIED IN PLANETARY EXPLORATION, SPACE PHYSICS, AND AVIONICS.

RTOP NO. 129-02-20 TITLE: QUANTUM ELECTRONICS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: PLOTKIN, H. H. TEL. 301-982-5503

TECHNICAL SUMMARY

CONDUCT LABORATORY STUDY OF PHYSICAL AND CHEMICAL PROPERTIES OF MATERIALS WHICH ARE RELEVANT TO PREDICTING THEIR BEHAVIOR AS LASER MATERIALS. EMPHASIS IS ON MATERIALS WHICH HAVE NEVER BEEN STUDIED FOR THEIR POTENTIAL USE IN LASERS. THE MAIN TASKS ARE: (1) UNDERSTANDING THE EXCITATION-EMISSION-DEGRADATION MECHANISMS IN AVAILABLE AND NEWLY DEVELOPED LASER MATERIALS; (2) ELUCIDATION OF TRANSFER OF ELECTRONIC EXCITATION ENERGY COMMON TO MOST LASERS; (3) USE OF ADVANCED SPECTROSCOPIC TECHNIQUES (EMISSION, ABSORPTION, FLASH, LIFETIME, ELECTRON SPIN RESONANCE, NUCLEAR MAGNETIC RESONANCE) TO EXPLAIN AND PREDICT THE PROCESSES TAKING PLACE FOLLOWING OPTICAL PUMPING; AND (4) DEVELOPMENT OF THEORETICAL FRAMEWORK ABLE OF CORRELATING LASER PERFORMANCE WITH SPECTRAL CHARACTERISTICS OF DIFFERENT MATERIALS.

RTOP NO. 129-02-21 TITLE: ELECTRON-WAVE INTERACTIONS

ORGANIZATION: NASA HEADQUARTERS

MONITOR: JOHNSON, P. S. TEL. 202-962-6351

TECHNICAL SUMMARY

THEORETICAL AND EXPERIMENTAL RESEARCH IN THE AREAS OF: ELECTRICAL TRANSPORT PHENOMENA SUCH AS INTERACTION OF ELECTRONS WITH ACOUSTIC WAVES AND OTHER LATTICE VIBRATIONS AS WELL AS WITH IMPRESSED

ELECTRIC AND MAGNETIC FIELDS; GENERATION AND AMPLIFICATION PROCESSES IN SEMICONDUCTORS; SUPERCONDUCTIVITY PHENOMENA SUCH AS IMPROVED PAIRING OF ELECTRONS EITHER WITH OR WITHOUT INTERVENTION OF PHONONS TO PRODUCE HIGHER TEMPERATURE SUPERCONDUCTORS; THIN FILM PHENOMENA TO DETERMINE ELECTRON INTERACTION WITH AN IMPERFECT OR INCOMPLETE LATTICE UNDER CONDITIONS OF RESTRICTED ELECTRON MOTION CAUSED BY A PREDOMINANTLY TWO DIMENSIONAL STRUCTURE; SOLID STATE SPECTROSCOPY OF LASER ACTIVE ATOMS IN A CRYSTALLINE HOST LATTICE; AMORPHOUS SEMICONDUCTORS TO PROVIDE IMPROVED UNDERSTANDING OF SWITCHING AND MEMORY PROPERTIES SO THAT THESE UNIQUE CHARACTERISTICS CAN BE FULLY APPLIED. THIS RESEARCH CONTRIBUTES TO THE DEVELOPMENT OF NEW AND IMPROVED ELECTRONIC COMPONENTS AND DEVICES NEEDED TO MEET INCREASED SOPHISTICATION AND RELIABILITY REQUIREMENTS IN THE SPACE EXPLORATION AND AVIATION TECHNOLOGY PROGRAMS.

RTOP NO. 129-02-21 TITLE: ELECTRON WAVE INTERACTIONS

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: LAURENCE, J. C. TEL. 216-433-6963

TECHNICAL SUMMARY

OBJECTIVE: THE PRIMARY OBJECTIVE OF THE LEWIS PROGRAM IS TO ACHIEVE INTENSE, STEADY MAGNETIC FIELDS IN LARGE VOLUME WITH A MINIMUM MASS AND POWER REQUIREMENT. PROGRESS TOWARD THIS OBJECTIVE REQUIRES BOTH BASIC AND APPLIED RESEARCH ON WAYS TO IMPROVE THE CURRENT DENSITY, OPERATING TEMPERATURE, AND STRENGTH OF SUPERCONDUCTING MATERIALS SUITABLE FOR USE IN LARGE COILS. A SECOND OBJECTIVE IS TO ACHIEVE BETTER UNDERSTANDING OF THE PHYSICAL PROCESSES INVOLVED IN CONDUCTION OF ELECTRICITY BOTH IN THE NORMAL AND THE SUPERCONDUCTING STATE, WITH A VIEW TO IMPROVING THE PERFORMANCE OF ELECTRICAL COMPONENTS OF AEROSPACE POWER AND PROPULSION SYSTEMS. APPROACH: SUPERCONDUCTORS WILL BE STUDIED THEORETICALLY AND EXPERIMENTALLY ON BOTH PHYSICS AND ENGINEERING LEVELS. IN NORMAL METALS AND SEMICONDUCTORS THE GALVANO-MAGNETIC EFFECTS (MAGNETORESISTANCE, HALL EFFECT, MAGNETOTHERMAL EFFECTS, ETC.) WILL BE STUDIED, ESPECIALLY IN HIGH FIELDS WHERE LANDAU QUANTIZATION IS IMPORTANT. THE PROCESSES OF EXCITATION AND DISSOCIATION OF GASES IN STRONG ELECTRIC AND MAGNETIC FIELDS WILL BE STUDIED. THE INTENT IN EACH AREA WILL BE TO UNDERSTAND AND TO DEVELOP MATERIALS AND PROCESSES WITH UNIQUE CHARACTERISTICS FOR SPECIFIC APPLICATIONS. VARIOUS FORMS OF SUPERCONDUCTORS (WIRE, RIBBON, COMPOSITES, ETC.) WILL BE TESTED IN SHORT SAMPLES AND IN ACTUAL COILS TO ASCERTAIN RELATIVE MERITS OF DIFFERENT MATERIALS AND CONSTRUCTION TECHNIQUES. IMPROVED SUPERCONDUCTING COMPOSITES WILL BE SOUGHT BY ANALYTIC AND EXPERIMENTAL METHODS IN ORDER TO IMPROVE SUPERCONDUCTING MAGNETS. THE HIGH FIELD SUPERCONDUCTING AND CRYOGENIC MAGNETS, DEVELOPED IN THE LERC MAGNET TECHNOLOGY PROGRAM WILL BE USED IN SUPERCONDUCTOR AND GALVANOMAGNETIC EXPERIMENTS. STUDIES OF MAGNET SYSTEMS WILL BE MADE TO MINIMIZE WEIGHT AND POWER REQUIREMENTS FOR SUPERCONDUCTIVITY MAGNET SYSTEMS TO OPERATE IN SPACE.

RTOP NO. 129-02-21 TITLE: ELECTRON-WAVE INTERACTIONS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-3285
TECHNICAL SUMMARY

EXPERIMENTAL AND THEORETICAL STUDIES ARE CONDUCTED ON THE MECHANISMS AND THE MAGNITUDES OF ELECTRON-FIELD INTERACTIONS IN SEMICONDUCTORS AND DIELECTRICS. THESE STUDIES ARE MADE TO ASSESS THE VALUE OF PHENOMENA FOR FUTURE AGENCY REQUIREMENTS AND TO DEVELOP A BASIS FOR NEW DEVICE TECHNOLOGY. RESEARCH ON OPTICAL AND ELECTRICAL RESPONSE IN DOPED ELEMENTAL AND COMPOUND SEMICONDUCTORS IS PERFORMED.

THIS RESEARCH INCLUDES BASIC EPR STUDIES, MEASUREMENT OF THE ION RANGE-ENERGY RELATIONSHIP, GALVANOMAGNETIC MEASUREMENTS, STUDIES OF ELECTRON TRANSPORT AND INSTABILITIES IN POLAR SEMICONDUCTORS. IN ADDITION, THE ELECTROMAGNETIC PROPERTIES OF DIELECTRIC MOLECULAR SOLIDS ARE INVESTIGATED. BASIC RESEARCH IS BEING PERFORMED AT THE BIOMOLECULAR LEVEL TO DETERMINE THE MECHANISM OF CELL DIVISION. MEASUREMENTS ARE MADE OF TRANSMEMBRANE POTENTIALS WITH PRECISE MEASUREMENT OF CONCENTRATION AND DISTRIBUTION OF SIGNIFICANT IONS (I.E. NA (+), K (+), CA (++) , CL (-)). RESULTS OF THIS RESEARCH WILL THEN PROVIDE AN UNDERSTANDING OF THE INFLUENCES OF VARIOUS SPACE ENVIRONMENTAL FACTORS ON MAN'S PERFORMANCE IN SPACE. THIS BASIC RESEARCH SUPPORTS THE DEVELOPMENT OF A QUANTITATIVE MATHEMATICAL THEORY ON THE ELECTRO-OSMOTIC MECHANISMS INVOLVED IN CONTROL OF MITOTIC PROCESSES. IN A CURRENT INVESTIGATION, STUDIES OF ABNORMAL CELLS LED TO THE DISCOVERY OF MITOTIC STIMULATION TAKING PLACE IN SARCOMA CELLS IN CULTURE THROUGH INTERCELLULAR BRIDGES. THIS WORK CONTINUES TO DETERMINE IF THERE IS, IN FACT, INTERCELLULAR MOLECULAR COMMUNICATION IN HUMAN TISSUE. PART OF THIS WORK WILL REQUIRE DEVELOPMENT OF ULTRAMICRO TECHNIQUES FOR HIGHLY LOCALIZED CHEMICAL ANALYSIS OF SUBCELLULAR STRUCTURES WITHIN HUMAN CELLS USING NEWLY AVAILABLE ELECTRON MICROPROBE INSTRUMENTATION.

RTOP NO. 129-02-21 TITLE: ELECTRON WAVE INTERACTIONS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THIS IS A PROGRAM OF EXPERIMENTAL AND THEORETICAL RESEARCH IN THE INTERACTION OF ELECTRONS WITH ELECTRIC AND MAGNETIC FIELDS. ITS OBJECTIVE IS TO PROVIDE BETTER UNDERSTANDING OF OSCILLATION, AMPLIFICATION AND DETECTION IN THIN FILMS AND SEMICONDUCTING MATERIALS; CERTAIN ASPECTS OF SUPERCONDUCTIVITY; AND REFRACTION AND ABSORPTION IN SOLIDS. THE INTENDED APPLICATION OF THE KNOWLEDGE OBTAINED IN THESE EFFORTS IS THE DEVELOPMENT OF BETTER COMPONENTS FOR SPACE ELECTRONIC SYSTEMS. DURING THE COMING YEAR, WORK WILL BE UNDERTAKEN ON THE FOLLOWING SPECIFIC TOPICS: (1) THIN FILM SUPERCONDUCTORS, (2) SPECIFIC AREAS OF QUANTUM THEORY SIGNIFICANT TO SOLID STATE PHYSICS, (3) ELECTRONIC PROPERTIES OF THIN-FILM BARRIERS, (4) THIN-FILM MAGNETO-OPTIC INFORMATION STORAGE, (5) SPACE-CHARGE-LIMITED (SCL) CURRENTS IN SEMICONDUCTORS AND INSULATORS, AND (6) PHOTO-EFFECTS IN THIN FILM SEMICONDUCTORS. THIN FILM SUPERCONDUCTOR INVESTIGATIONS INCLUDE APPLICATIONS OF THE JOSEPHSON-EFFECT TO COMPUTER MEMORY CELLS AND INFRARED DETECTORS, AND

SUPERCONDUCTING THIN-FILM TRANSMISSION LINES. THEORETICAL WORK IN CRYSTAL ENERGY BANDS, MOLECULAR ENERGY LEVELS AND ELECTRONIC PROPERTIES OF METALS POINTS ULTIMATELY TOWARD IMPROVED ELECTRONIC DEVICES. THIN-FILM BARRIER STUDIES HAVE AS A GOAL THE DEVELOPMENT OF NEW HIGH-SPEED CHARGE-STORAGE MEMORY DEVICES. THE FEASIBILITY OF ADVANCED SPACECRAFT MEMORIES BASED ON MAGNETIC PHENOMENA IS BEING DETERMINED IN THE MAGNETO-OPTIC INFORMATION STORAGE TASK. DEVELOPMENT OF SOLID STATE DIODES AND TRIODES IS ANTICIPATED FROM THE WORK IN SCL CURRENTS. THE PHOTO-EFFECTS EFFORT IS AIMED AT IMPROVED EFFICIENCY IN LIGHT DETECTION AND ENERGY CONVERSION.

RTOP NO. 129-02-22 TITLE: PLASMA DYNAMICS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO ADVANCE THE SCIENTIFIC UNDERSTANDING OF ELECTROMAGNETIC FIELD INTERACTIONS WITH IONIZED GASES (PLASMAS) AND THE MOTION OF PLASMAS UNDER THE INFLUENCE OF EXTERNAL ELECTROMAGNETIC FIELDS. THE WORK WILL EMPHASIZE ADVANCEMENT OF KNOWLEDGE IN CHEMICAL KINETICS (RATES OF DISSOCIATION, EXCITATION, IONIZATION, AND RECOMBINATION) AND THE ATOMIC AND MOLECULAR PROPERTIES, SUCH AS LIFETIMES, CROSS SECTIONS, AND ENERGY LEVELS, WHICH ARE SIGNIFICANT IN PLASMA DYNAMIC SYSTEMS. THE APPLICATIONS FOR WHICH THESE RESULTS WILL BE NEEDED ARE: MPD ACCELERATORS FOR SPACECRAFT ELECTRIC PROPULSION, MHD GENERATORS FOR NUCLEAR POWER CONVERSION, HIGH POWER LASERS FOR COMMUNICATION, AND THERMIONIC DIODES FOR POWER CONVERSION. THE SPECIFIC EFFORTS TO BE UNDERTAKEN IN FY'71 ARE: (1) THE STUDY OF RATE PROCESSES IN PARTIALLY IONIZED GASES, SPECIFICALLY DIRECTED TOWARD MAGNETOGASDYNAMIC LASERS, NUCLEAR LASERS AND NONEQUILIBRIUM MHD GENERATORS, (2) PRODUCTION OF ATOMIC AND MOLECULAR POPULATION INVERSION IN MAGNETOGASDYNAMIC DEVICES FOR APPLICATION TO HIGH POWER LASERS, (3) ION CYCLOTRON RESONANCE AND ELECTRON SCATTERING STUDIES TO OBTAIN REACTION CROSS SECTIONS, PRODUCT DISTRIBUTIONS, AND ENERGY LEVELS SIGNIFICANT TO LASER APPLICATIONS, AND (4) PLASMA THERMIONICS RESEARCH AIMED TOWARD IMPROVEMENT IN PERFORMANCE OF CESIUM THERMIONIC DIODES.

RTOP NO. 129-02-22 TITLE: PLASMA DYNAMICS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: THOM, K. TEL. 202-962-6351
TECHNICAL SUMMARY

FUNDAMENTAL RESEARCH ON SPECIAL PLASMA DYNAMIC PROBLEMS, UNDER A GRANT AND CONTRACT PROGRAM, UTILIZING UNIQUE EXPERTISE AND COMPETENCE AVAILABLE AT UNIVERSITIES AND OTHER RESEARCH INSTITUTIONS, FOR FILLING TECHNICAL GAPS AND THEREBY SUPPORTING THE CENTERS' RESEARCH IN THOSE AREAS IN WHICH IN-HOUSE COMPETENCE DOES NOT EXIST. SPECIFIC RESEARCH OBJECTIVES ARE: PLASMA BOUNDARY LAYERS, PLASMA SURFACE INTERACTIONS, EXCITATION AND IONIZATION CROSS SECTIONS AT LOW (THERMAL) IMPACT ENERGIES AND IN GASES THAT ARE CANDIDATES AS WORKING FLUIDS IN PLASMA THRUSTERS AND PLASMA POWER SOURCES, PLASMA TRANSPORT

PROPERTIES, PLASMA TURBULENCE, NONEQUILIBRIA IN PLASMAS, PROPERTIES OF URANIUM PLASMAS, AND INTERACTIONS OF NEUTRON FLUX WITH URANIUM PLASMA FOR INVESTIGATION OF FISSIONING PLASMAS, AND THE EXCITATION OF INVERTED EXCITED STATES BY FISSION FRAGMENTS.

RTOP NO. 129-02-22 TITLE: PLASMA DYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

IN THEORETICAL MPD RESEARCH, ANALYSIS PERTAINING TO USE OF AN IONIZED BARIUM CLOUD AS A MEANS OF DETERMINING THE TOPOLOGY OF THE EARTH'S MAGNETIC FIELD AND CONVECTIVE MOTIONS WITHIN IT ARE CONTINUED. THEORETICAL STUDIES ARE MADE OF NONLINEAR BEHAVIOR OF COLLISIONLESS PLASMAS AND NATURE OF PLASMA TURBULENCE, SUCH STUDIES BEING NEEDED IN DEVELOPING DEEPER UNDERSTANDING OF GEOPHYSICAL PHENOMENA. THEORETICAL DETERMINATION IS MADE OF TRANSPORT PROPERTIES OF HIGH-TEMPERATURE GASES AND PLASMAS. EXPLOITATION OF NUMERICAL COMPUTER EXPERIMENT TECHNIQUES FOR SOLVING ASTRONOMICAL AND PLASMA PROBLEMS CONTINUES. PREVIOUSLY UNIDENTIFIED SPECTRAL LINES OF HIGHLY IONIZED ELEMENTS ARE PRODUCED IN THE LAB. AND IDENTIFIED. RADIATION SOURCES INCLUDE GIANT-PULSE-LASER PRODUCED PLASMAS, PLASMA-FOCUS APPARATUS AND THETA-PINCH APPARATUS. RESULTS WILL BE USED IN IDENTIFYING FOR FIRST TIME SOLAR SPECTRA OBTAINED BY ROCKETS AND SATELLITES; WIDESPREAD DEMAND BY THE SCIENTIFIC COMMUNITY FOR SUCH SPECTRA WILL BE SATISFIED. THEORETICAL AND DIAGNOSTIC STUDIES ARE MADE OF ION LASERS WITH THE AIM OF INCREASING THEIR POWER (GREATER THAN 100 W) AND EFFICIENCY (GREATER THAN 0.1 PERCENT). SUCH LASERS ARE UNIQUE IN PRODUCING OPTICAL RADIATION IN THE VISIBLE (BLUE-GREEN), HENCE HAVE IMPORTANT POTENTIAL APPLICATIONS (E.G. SPACE AND UNDERWATER COMMUNICATION). ADVANCEMENT OF ARC-HEATER TECHNOLOGY IS SOUGHT WITH THE OBJECT OF IMPROVING AND EXTENDING LAB SIMULATION OF HYPERSONIC FLIGHT; EFFORTS INCLUDE EXTENDING ENTHALPY AND PRESSURE OF MOST ADVANCED HEATERS AND CONTINUED DEVELOPMENT OF ROTARY-ARC HEATERS. ONE RESEARCH USE MADE OF THE MOST ADVANCED ARC-HEATING FLOW FACILITY IS STUDY OF ELECTRON ATTACHMENT BY ELECTROPHYLIC MATERIALS. A FARADAY-TYPE LINEAR-PLASMA ACCELERATOR IS BROUGHT TO OPERATIONAL STATUS AND ITS USE AS A HIGH-ENTHALPY FLOW APPARATUS TO STUDY CERTAIN ENTRY MATERIALS PROBLEMS IS STUDIED.

RTOP NO. 129-02-22 TITLE: PLASMA DYNAMICS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: RAYLE, W. D. TEL. 216-433-6203
TECHNICAL SUMMARY

RESEARCH IS DIRECTED TOWARD GAINING UNDERSTANDING OF PLASMA BEHAVIOR IN USEFUL RANGES OF DENSITY, TEMPERATURE, AND MAGNETIC FIELD STRENGTHS. THE AIM IS TO GAIN THE ABILITY TO GENERATE, CONFINE, AND MANIPULATE PLASMAS OF DESIRABLE CHARACTERISTICS IN WAYS RELEVANT TO POTENTIAL APPLICATIONS OF IMPORTANCE TO NASA PROGRAMS. THEORETICAL AND EXPERIMENTAL TOOLS WILL BE INVESTIGATED AND DEVELOPED TO IMPROVE OUR UNDERSTANDING AND TO CHECK THAT UNDERSTANDING WITH SPECIFIC

EXPERIMENTS. APPLICATIONS FOR THE KNOWLEDGE SOUGHT ARE WIDESPREAD, INCLUDING MHD POWER GENERATION, PLASMA THRUSTERS AND THERMONUCLEAR PLASMAS. EXPERIMENTALLY, THE APPROACH IS FIRST TO IDENTIFY SPECIFIC PLASMA PROCESSES RELEVANT TO SPECIFIC POTENTIAL APPLICATIONS, CONCERNING WHICH THE PRESENT STATE OF KNOWLEDGE IS INADEQUATE. THEN TO DEVISE MEANS BY WHICH A PLASMA DEMONSTRATING SUCH A PROCESS MAY BE GENERATED AND DIAGNOSED. AMONG THE PLASMA PROCESSES BEING STUDIED EXPERIMENTALLY AND/OR THEORETICALLY ARE LOSS-CONE INSTABILITIES, NON-EQUILIBRIUM IONIZATION, INTERACTION OF FLOWING PLASMAS WITH MAGNETIC FIELDS, TURBULENCE AND DIFFUSION, PLASMA WAVE INTERACTIONS FOR PLASMA HEATING AND AS DIAGNOSTIC TOOLS, AND PLASMA ION HEATING PROCESSES.

RTOP NO. 129-02-22 TITLE: PLASMA DYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO ADVANCE THE SCIENTIFIC UNDERSTANDING OF (1) ELECTROMAGNETIC FIELD INTERACTIONS WITH PLASMAS, (2) GENERATION OF PLASMAS AND (3) PLASMA MOTION. SPECIFICALLY THE WORK WILL BE CONCERNED WITH THE ADVANCEMENT OF ELECTRIC ARC PHYSICS FOR THE PRODUCTION OF HIGH ENTHALPY GAS FLOWS, LINEAR ACCELERATION OF UNSEEDED NITROGEN OR AIR, PLASMA PROPERTIES SUCH AS TRANSITION PROBABILITIES, ETC., CONTINUUM MHD THEORY FOR PULSED PLASMA ACCELERATION AND COMPUTER SIMULATIONS OF PLASMA PARTICLE DYNAMICS AND THEORETICAL ANALYSIS OF THE INTERACTION OF SPACE MAGNETIC FIELDS AND THE SOLAR WINDS. THIS INFORMATION CAN HAVE APPLICATION IN MANY FIELDS INCLUDING SIMULATION OF PLANETARY ENTRY HEATING ENVIRONMENTS, ELECTROMAGNETIC PROPULSION, SPACE POWER GENERATION, LASER POWER AND LASER COMMUNICATIONS AND SOLAR PHYSICS.

RTOP NO. 129-02-23 TITLE: NUCLEAR PHYSICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

THIS RESEARCH PROGRAM IN INTERMEDIATE ENERGY PHYSICS IS DIRECTED TOWARD A BETTER UNDERSTANDING OF THE ATOMIC NUCLEUS, INCLUDING ITS STRUCTURE, THE NATURE OF THE FORCES WHICH ACT AMONG ITS CONSTITUENTS, AND ITS BEHAVIOR DURING INTERACTIONS WITH SUB-ATOMIC PARTICLES, SPECIFICALLY, BEAMS OF PROTONS, PIONS, AND MUONS AVAILABLE AT THE SPACE RADIATION EFFECTS LABORATORY. BASIC RESEARCH PROVIDES THE DATA UPON WHICH VALID THEORETICAL MODELS MAY BE CONSTRUCTED; THE EXTENSION OF THESE MODELS TO ENGINEERING PROBLEMS DEALING WITH RADIATION SHIELDING. THREE UNIVERSITIES, THE UNIVERSITY OF VIRGINIA, VIRGINIA POLYTECHNIC INSTITUTE, AND THE COLLEGE OF WILLIAM AND MARY ARE PARTICIPATING IN THIS PROGRAM. IN-HOUSE WORK CONTINUES INVESTIGATIONS OF THE BASIC INTERACTIONS OF ENERGETIC PROTONS AND MESONS TO VERIFY THE VARIOUS THEORETICAL MODELS USED TO PREDICT BOTH THE CASCADE AND EVAPORATION PROCESSES OF SECONDARY PRODUCTION AND NUCLEAR ENERGY DECAY.

RTOP NO. 129-02-23 TITLE: NUCLEAR PHYSICS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: BLUE, J. W. TEL. 216-433-4000
TECHNICAL SUMMARY

THE TITLE OF THIS RESUME IS NUCLEAR PHYSICS IN THE BROADEST SENSE AND INCLUDES THE INTERACTION OF NUCLEAR RADIATIONS WITH MATTER AND NUCLEAR PHYSICS APPLIED TO TECHNOLOGY, AS WELL AS THE MORE CONVENTIONAL MEANING: THE PROPERTIES OF NUCLEI AND NUCLEAR REACTIONS. THE WORK HAS BEEN DIVIDED INTO CATEGORIES WHICH ARE NUMBERED FOR REFERENCE IN OTHER SECTIONS OF THIS RESUME. PROJECT 1: THEORETICAL NUCLEAR REACTION STUDIES. PROJECT 2: EXPERIMENTAL MEASUREMENTS OF BASIC NUCLEAR DATA. PROJECT 3: MEASUREMENT OF PHENOMENA RELATED TO REACTOR TECHNOLOGY. PROJECT 4: DEVELOPMENT OF NUCLEAR INSTRUMENTATION. PROJECT 5: EFFECTS OF NUCLEAR RADIATIONS ON VARIOUS MATERIALS. PROJECT 6: TECHNOLOGICAL APPLICATIONS OF NUCLEAR PHYSICS.

RTOP NO. 129-03-20 TITLE: HIGH TEMPERATURE MATERIALS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: MALTZ, J. TEL. 202-962-0054
TECHNICAL SUMMARY

THE BEHAVIOR AND PROPERTIES OF NEW SUPERALLOYS, REFRACTORY METALS, CERAMICS AND GRAPHITE ARE BEING INVESTIGATED AS A FUNCTION OF TEMPERATURE AND ENVIRONMENT. STRENGTHENING AND DUCTILIZING MECHANISMS ARE BEING DETERMINED. THE RELATIONSHIPS BETWEEN MICROSTRUCTURE AND PROPERTIES ARE BEING CORRELATED WHICH SHOULD LEAD TO IMPROVEMENTS IN PERFORMANCE, RELIABILITY, FABRICATING, AND REPRODUCIBILITY.

RTOP NO. 129-03-20 TITLE: HIGH TEMPERATURE MATERIALS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DETERMINE THE BEHAVIOR AND THE SUITABILITY OF COATED OR UNCOATED METALLIC ALLOYS FOR SERVICE IN ADVANCED AIRCRAFT AND SPACECRAFT. THE SCOPE OF THE STUDIES SHALL PRIMARILY ENCOMPASS ALLOYS OF NICKEL, COBALT, AND THE REFRACTORY METALS AS WELL AS COATINGS FOR THERMAL CONTROL OR FOR PROTECTION FROM ATTACK BY ENVIRONMENTAL SPECIES. THE MATERIALS, USUALLY THIN SHEET, SHALL BE EXPOSED TO APPROPRIATE CYCLES OF TEMPERATURE, PRESSURE, STRESS, AND TIME. SOME ATTENTION WILL ALSO BE GIVEN TO EXPLORATION OF ADVANCED FABRICATION AND JOINING METHODS AND TO THE ENVIRONMENTAL EXPOSURE OF FABRICATED SPECIMENS WITH OR WITHOUT APPLIED STRESS. LIMITED WORK WILL ALSO BE DIRECTED AT STUDY OF THE MECHANISMS INVOLVED IN THE DEGRADATION OF THERMAL CONTROL COATINGS. RESULTS OF THESE STUDIES WILL PROVIDE INFORMATION ON THE BASIC BEHAVIOR OF HIGH TEMPERATURE ALLOYS AND COATINGS AND WILL ESTABLISH THE SUITABILITY AND LIMITATIONS OF THESE MATERIALS FOR APPLICATIONS IN ADVANCED AEROSPACE VEHICLES.

RTOP NO. 129-03-20 TITLE: HIGH TEMPERATURE MATERIALS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: AULT, G. M. TEL. 216-433-6387
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS RESEARCH ARE TO DEVELOP NEW HIGH TEMPERATURE MATERIALS WITH SUPERIOR PROPERTIES FOR VARIOUS AEROSPACE APPLICATIONS AND TO EXTEND PROCESSING TECHNOLOGY SO THAT ADVANCED MATERIALS CAN BE EFFECTIVELY EXPLOITED IN SUCH APPLICATIONS. A SEPARATE OBJECTIVE IS TO DEVELOP SUITABLE LOW-COST MATERIALS FOR APPLICATION TO AFTERBURNER DEVICES INTENDED TO REDUCE THE LEVEL OF AUTOMOBILE EXHAUST GAS EMISSIONS. TO ACHIEVE THESE OBJECTIVES RESEARCH IS UNDERWAY TO EXTEND THE HIGH TEMPERATURE CAPABILITY OF A NUMBER OF METALLIC ALLOY SYSTEMS AND SEVERAL NONMETALLIC ALLOY SYSTEMS. ALLOYING, DISPERSION STRENGTHENING, PRE-ALLOYED POWDER TECHNOLOGY AND THERMOMECHANICAL PROCESSING ARE MAJOR TECHNIQUES UNDER INVESTIGATION TO ENHANCE THE CAPABILITY OF VARIOUS METALLIC SYSTEMS. SPECIFIC JOINING TECHNIQUES SUCH AS SOLID STATE WELDING ARE AMONG THE PROMISING TECHNIQUES BEING STUDIED. IMPLICIT IN EACH RESEARCH AREA ARE BASIC STUDIES DESIGNED TO CONTRIBUTE TO THE UNDERSTANDING OF FUNDAMENTAL MATERIAL BEHAVIOR. THIS PROGRAM COUPLES WITH OTHER IN-HOUSE AND CONTRAC WORK UNDER RTOP'S 129-03-21, 129-03-23, AND 129-03-28.

RTOP NO. 129-03-21 TITLE: LIGHT ALLOYS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO OBTAIN AN INCREASED UNDERSTANDING OF THE PROCESSING AND PHENOMENA WHICH CONTROL THE HYDROGEN EMBRITTLEMENT PROCESS. RESULTS OF THIS WORK HAS APPLICATION IN DESIGN OF VESSELS FOR HYDROGEN GAS STORAGE, BOTH ON THE GROUND AND ON AIRCRAFT AND SPACECRAFT.

RTOP NO. 129-03-21 TITLE: LIGHT ALLOYS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: AULT, G. M. TEL. 216-433-6387
TECHNICAL SUMMARY

A MAJOR OBJECTIVE IS TO OBTAIN A BETTER UNDERSTANDING OF THE FAILURE OR FRACTURE MECHANISMS THAT ARE INVOLVED IN THE APPLICATION OF ADVANCED MATERIALS TO AEROSPACE MISSIONS. A SECOND MAJOR OBJECTIVE IS TO DEVELOP METHODS FOR PREDICTING THE LIFE OF SPECIMENS AND COMPONENTS WHEN THEY ARE SUBJECTED TO COMPLEX PATTERNS OF TEMPERATURES AND LOADS AS A FUNCTION OF TIME. TO ACHIEVE THESE OBJECTIVES, RESEARCH IS UNDERWAY TO EXTEND EXISTING ANALYSES AND TO DEVELOP NEW APPROACHES FOR DETERMINING THE STRESS AND STRAIN DISTRIBUTIONS IN THE VICINITY OF DISCONTINUITIES SUCH AS FLAWS OR CRACKS, AND TO UNDERSTAND THE REACTION OF AEROSPACE MATERIALS TO THESE DISCONTINUITIES WHEN SUBJECTED TO VARIOUS ENVIRONMENTAL CONDITIONS. APPROACHES ARE ALSO BEING EXAMINED FOR PREDICTING THE TIME TO THE INITIATION OF THE FIRST DETECTABLE CRACKS AS A RESULT OF

MECHANICAL AND THERMAL FATIGUE AND TO PREDICTING THE PROPAGATION RATE OF THE CRACKS. EFFECTS OF CRYOGENIC AND ELEVATED TEMPERATURES ON THE FAILURE MECHANISMS ARE BEING STUDIED AS WELL AS THE EFFECT OF HIGH PRESSURE ON THE FLOW AND FRACTURE OF MATERIALS SUCH AS CHROMIUM. THIS PROGRAM COUPLES WITH OTHER IN-HOUSE AND CONTRACT WORK UNDER RTOP 126-15-16.

RTOP NO. 129-03-21 TITLE: LIGHT ALLOYS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP IMPROVED UNDERSTANDING OF THE BEHAVIOR OF LIGHT STRUCTURAL ALLOYS UNDER THE LANDING AND ENVIRONMENTAL CONDITIONS EXPERIENCED IN ADVANCED AEROSPACE VEHICLES. OF SPECIAL INTEREST IS A BETTER UNDERSTANDING OF INTERACTIONS BETWEEN STRESSES, ENVIRONMENTS, AND EXPOSURE TIMES UNDER STATIC OR CYCLIC CONDITIONS. THE WORK INCLUDES STUDIES OF FATIGUE AND CORROSION PHENOMENA AND THEIR INTERACTIONS AND TREATS EXPERIMENTAL STUDIES SIMULATING TYPICAL FLIGHTS OF SUPERSONIC AIRCRAFT WITH GROUND-AIR-GROUND CYCLES, INVESTIGATION OF FATIGUE BEHAVIOR IN A REDUCED PRESSURE ENVIRONMENT, AND INVESTIGATION OF EMBRITTLEMENT, STRESS CORROSION, CRACK INITIATION AND PROPAGATION, AND FRACTURE OF STRUCTURAL SHEET MATERIALS IN VARIOUS ENVIRONMENTS. THE FATIGUE RESEARCH WILL INCLUDE BOTH REAL TIME AND COMPRESSED TIME TESTS TO IDENTIFY VARIABLES WHICH INFLUENCE FATIGUE BEHAVIOR MOST SIGNIFICANTLY. EFFORT WILL ALSO BE DIRECTED AT DEVELOPMENT OF ANALYTICAL MODELS THAT MAY BE USED TO PREDICT IMPACT CRATERING OF QUASI-INFINITE AND FINITE TARGETS AS WELL AS MULTIPLE PLATES, AND AT EVALUATION OF EFFECTS OF PROCESSING VARIABLES ON THE MARTENSITIC PHASE TRANSFORMATION AND MEMORY RECOVERY CAPABILITY OF 55-NITINOL ALLOY. THESE STUDIES WILL PROVIDE THE BASIS FOR A BETTER UNDERSTANDING OF THE PRINCIPLES THAT GOVERN BEHAVIOR OF MATERIALS UNDER CONDITIONS OF INTEREST FOR STRUCTURES FOR FUTURE FLIGHT VEHICLES.

RTOP NO. 129-03-21 TITLE: LIGHT ALLOYS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: RARING, R. H. TEL. 202-962-0054
TECHNICAL SUMMARY

STRUCTURAL MATERIALS WITH HIGHER STRENGTH-TO WEIGHT RATIOS (S/W), AND THAT ARE ECONOMIC, RELIABLE, AND IN ADEQUATE SUPPLY, ARE A CONTINUING NEED FOR AEROSPACE VEHICLES. THESE NEEDS COVER TEMPERATURES FROM THE NEAR ABSOLUTE ZERO TO THE HIGHEST POSSIBLE. THE MATERIALS MUST BE COMPATIBLE WITH MANY SEVERE ENVIRONMENTS THAT CHANGE AS THE SPEEDS, FUELS, OXIDANTS, ETC. CHANGE WITH NEW MISSIONS. AMONG THE SEVERAL PROBLEMS THAT THWART THE FULL USE OF OUR HIGHEST S/W MATERIALS ARE STRESS-CORROSION CRACKING, HYDROGEN EMBRITTLEMENT, UNRELIABILITY, AND EXCESSIVE BRITTLINESS. THIS RESEARCH ATTACKS THESE PROBLEMS. APPLICATION WOULD LEAD TO LIGHTER AND MORE RELIABLE PRESSURE VESSELS FOR SPACECRAFT, PRACTICAL HYDROGEN-FUELED AIRCRAFT

ENGINES, MORE RELIABLE NUCLEAR ROCKETS AND TURBOJET ENGINES THAT ARE LIGHTER IN WEIGHT, MORE RELIABLE, AND MORE EFFICIENT.

RTOP NO. 129-03-21 TITLE: LIGHT ALLOYS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

LONG TERM PROPERTIES OVER A WIDE RANGE OF TEMPERATURES ARE BEING MEASURED ON THE LIGHT-WEIGHT, HIGH-STRENGTH MATERIALS NECESSARY FOR FUTURE SPACE VEHICLES. BOTH PARENT METAL AND WELDED JOINT SPECIMENS OF ALUMINUM, BERYLLIUM, AND TITANIUM MATERIALS WILL BE SUBJECTED TO LOW CYCLE THERMAL FATIGUE, AND FRACTURE TOUGHNESS WILL BE DETERMINED AS A FUNCTION OF THE LENGTH OF EXPOSURE. ALSO, CORROSION AND STRESS-CORROSION RESISTANCE WILL BE MEASURED BASED ON THE CHANGES IN PRECIPITATION AND GRAIN STRUCTURE DUE TO THE THERMAL HISTORY. FOR BORON-ALUMINUM, HIGH CYCLE FATIGUE LIFE AND ITS EFFECT ON STATIC STRENGTH WILL BE DETERMINED BECAUSE OF THE CRITICAL NATURE OF THIS MATERIAL. FINALLY, CORROSION OF ALUMINUM ALLOYS AND COATINGS IN HIGH-OXYGEN, HIGH-HUMIDITY ENVIRONMENTS WILL BE DETERMINED TO AID IN DESIGNING LONG LIFE INTO SPACE VEHICLE CABINS.

RTOP NO. 129-03-22 TITLE: POLYMERS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: ACHHAMMER, B. G. TEL. 202-962-0054
TECHNICAL SUMMARY

BASIC RESEARCH ON POLYMERIC MATERIALS, SUCH AS PLASTICS AND ELASTOMERS IS BEING CONDUCTED IN ORDER TO PROVIDE THE NASA WITH FUNDAMENTAL KNOWLEDGE NEEDED TO PRODUCE REQUIRED MATERIALS FOR ADVANCED AEROSPACE MISSIONS. POSSIBLE SYNTHESIS OF AN ORGANIC SUPERCONDUCTOR IS BEING INVESTIGATED AS A MEANS OF OBTAINING HIGH TC MATERIALS. THE BASIC MECHANISMS OF POLYMER IGNITION ARE BEING STUDIED TO PROVIDE THE UNDERSTANDING NEEDED TO MAKE LESS FLAMMABLE MATERIALS.

RTOP NO. 129-03-22 TITLE: POLYMERS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO CONDUCT FUNDAMENTAL RESEARCH ON THE PROPERTIES AND BEHAVIOR OF POLYMERS WITH A VIEW TOWARD THEIR APPLICATION IN THE PHYSICAL AND LIFE SCIENCES AND IN SPACE TECHNOLOGY. SPECIFICALLY THIS WORK WILL DEAL WITH FORMULATION AND EVALUATION OF ABLATIVE AND FIR-SUPPRESSION MATERIALS, INVESTIGATION OF THE EFFECT OF WAVELENGTH OF RADIATION ON MATERIAL RESPONSE IN A HEATING ENVIRONMENT, MECHANISMS BY WHICH THE SPACE ENVIRONMENT CAN ALTER THE MOLECULAR STRUCTURE OF POLYMERS, THE PHOTOCHEMISTRY OF SMOG FORMATION AND POLYMERIC MEMBRANES HAVING SELECTIVE PERMEABILITY TO ORGANIC AND INORGANIC MOLECULES. APPLICATIONS FOR THIS WORK ARE IN

FIELDS OF SPACECRAFT HEAT PROTECTION, FIRE SUPPRESSION, ENVIRONMENTAL EFFECTS ON MATERIALS, AIR AND WATER POLLUTION AND PURIFICATION AND NEUROPHYSIOLOGY.

RTOP NO. 129-03-22 TITLE: POLYMERS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

PROGRAMS INCLUDED IN THIS RESUME ARE: (1) DEVELOPMENT OF THERMALLY STABLE RESINS FOR ADHESIVE AND LAMINATING APPLICATIONS THE OBJECTIVE OF THIS PROGRAM IS TO DEVELOP A RESIN SYSTEM FOR STRUCTURAL ADHESIVE AND LAMINATING APPLICATIONS IN WHICH THE FABRICATED PRODUCT MUST SUSTAIN LONG TERM EXPOSURES TO TEMPERATURES OF 800°F AND ABOVE. RESINS CURRENTLY AVAILABLE EITHER DO NOT MEET THESE THERMAL CRITERIA OR LACK THE PROCESSABILITY ESSENTIAL TO FABRICATION TECHNIQUES. (2) DEVELOPMENT OF AN IMPROVED THERMAL CONTROL FILM MATERIAL A THERMAL CONTROL FILM MATERIAL MUST NOT ONLY EXHIBIT THE DESIRED RANGE OF SOLAR ABSORPTANCE, BUT MUST POSSESS LONG TERM STABILITY TOWARD SOLAR RADIATION. A SPECIAL WHITE TEDLAR FILM APPLIED ON THE APOLLO TELESCOPE MOUNT PERFORMS IN THE NECESSARY ABSORPTANCE RANGE, BUT ITS SOLAR RADIATION STABILITY IS QUESTIONABLE. CURRENT AND FUTURE USAGE REQUIRE EXTENDED STABILITY. (3) DEVELOPMENT OF STRUCTURAL ADHESIVE SYSTEMS SUITABLE FOR USE WITH LIQUID OXYGEN A STRUCTURAL ADHESIVE ADHESIVE SYSTEM WHICH IS COMPATIBLE WITH LIQUID OXYGEN IS NEEDED FOR VEHICLE APPLICATION IN AREAS SUBJECT TO CONTACT WITH LIQUID OXYGEN.

RTOP NO. 129-03-22 TITLE: POLYMERS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE IS TO CONDUCT BASIC RESEARCH ON THE PROPERTIES AND BEHAVIOR OF POLYMERS WITH A VIEW TOWARD THEIR APPLICATION IN AEROSPACE STRUCTURES. SPECIAL EMPHASIS WILL BE PLACED ON RELATING MOLECULAR STRUCTURE TO CHEMICAL AND PHYSICAL PROPERTIES, THEREBY LAYING A BROAD FOUNDATION TO SUPPORT THE DEVELOPMENT OF MANY MATERIALS WITH DIFFERENT PROPERTIES FOR A DIVERSITY OF APPLICATIONS. NEW MATERIALS, METHODS OF FABRICATION, AND TEST EVALUATION PROCEDURES REQUIRING BOTH WIND TUNNEL AND SMALL VEHICLE FLIGHT TESTS ARE ENVISIONED. THE RESULTS WILL LEAD TO MORE EFFECTIVE MATERIALS AND METHODS OF FABRICATION OF A VARIETY OF POLYMERIC MATERIALS FOR AIRCRAFT AND SPACECRAFT COMPONENTS.

RTOP NO. 129-03-22 TITLE: POLYMERS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6568
TECHNICAL SUMMARY

THIS IS A TWO-PART PROGRAM OF FUNDAMENTAL RESEARCH ON THE ELECTRICAL AND MECHANICAL BEHAVIOR OF POLYMERS. THE TWO AREAS ARE

RELATED BY THE FACT THAT LONG AND SHORT RANGE MOLECULAR MOTIONS CAN CONTROL THE PHYSICAL RESPONSE OF A POLYMER. THE ELECTRICAL PROPERTIES RESEARCH IS INTENDED TO ACHIEVE UNDERSTANDING AND CONTROL OF ELECTRONIC CONDUCTIVITY IN POLYMERIC MATRICES, WITH A LONG RANGE GOAL OF ATTEMPTING TO CREATE A POLYMERIC SUPERCONDUCTOR. THE MECHANICAL PROPERTIES RESEARCH IS INTENDED TO DETERMINE THE MOLECULAR PARAMETERS WHICH CONTROL RHEOLOGICAL BEHAVIOR. THIS HAS BEEN SUCCESSFUL IN SIMPLE AMORPHOUS SYSTEMS WHICH ARE NOT CHEMICALLY REACTING. THE GOAL NOW IS TO EXTEND THIS WORK FIRST TO LONGER TIMES, WHERE DEGRADATION MAY SET IN, AND THEN TO SHORTER TIMES, WHERE THE MATERIAL IS GLASS-HARD. IN BOTH CASES THE GENERAL APPROACH SHOULD INVOLVE THE SYNTHESSES OF BOTH NEW AND MODIFIED POLYMERIC AND PROTOTYPE CHEMICAL STRUCTURES, THE CHARACTERIZATION OF THESE MATERIALS AND THE DETERMINATION OF CHEMICAL STRUCTURE AND PROPERTY RELATIONSHIPS. APPLICATIONS FOR THE ELECTRICAL PROPERTY EFFORT MIGHT RANGE FROM IMPROVEMENTS IN HIGH VOLTAGE INSULATION AND NEW PHOTODETECTION TO MHD REENTRY SHIELDS; FOR THE MECHANICAL PROPERTIES WORK, IMPROVED SOLID PROPELLANTS, SEALANTS FOR HIGH-SPEED AIRCRAFT AND NEW TYPES OF REINFORCED PLASTICS.

RTOP NO. 129-03-23 TITLE: COMPOSITE MATERIALS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEFINE AND INVESTIGATE SUPERIOR REINFORCEMENTS AND MATRIX MATERIALS FOR FILAMENTARY COMPOSITES AND TO STUDY THE FUNDAMENTAL MECHANICAL AND CHEMICAL BEHAVIOR OF STRUCTURAL COMPOSITES. THE WORK WILL FOCUS ON INVESTIGATION OF NEW OR ADVANCED FILAMENTARY MATERIALS AND COMPOSITES TO ESTABLISH MECHANICAL PROPERTIES WITH A VIEW TOWARD THEIR STRUCTURAL APPLICATIONS IN ADVANCED AERONAUTICAL AND SPACE VEHICLES. STUDIES WILL ALSO BE MADE OF ADHESIVES AND RESINS, AND THE BONDING OF FILAMENTARY COMPOSITES TO STRUCTURAL METALS. THIS PROGRAM WILL YIELD INFORMATION ON THE FUNDAMENTAL BEHAVIOR OF ADVANCED COMPOSITES AND WILL PROVIDE A BASIS FOR SELECTING ADVANCED COMPOSITES FOR FURTHER STUDIES AIMED AT APPLICATIONS IN FLIGHT VEHICLES.

RTOP NO. 129-03-23 TITLE: COMPOSITE MATERIALS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: AULT, G. M. TEL. 216-433-6387
TECHNICAL SUMMARY

THE OVER-ALL OBJECTIVE OF THIS RESEARCH IS TO DEVELOP FIBER AND LAMINATE COMPOSITE MATERIALS, STRUCTURES, AND COMPONENTS FOR VARIOUS AEROSPACE APPLICATIONS. BOTH PLASTIC AND METAL MATRIX COMPOSITES UNDER STUDY MUST EXHIBIT GREATER STRENGTHS, TOUGHNESS, MODULUS OF ELASTICITY, AND WHEREVER POSSIBLE, LIGHTER WEIGHT THAN USUAL BULK, MONOLITHIC ENGINEERING MATERIALS. SUPERIOR PROPERTY-TO-WEIGHT ADVANTAGES (E.G. SPECIFIC WEIGHT OR SPECIFIC MODULI) MUST BE MAINTAINED AT TEMPERATURE LEVELS OF INTEREST WHICH RANGE FROM CRYOGENIC TEMPERATURES TO OVER 2500 DEGREES F. SINCE MOST OF THE

EFFORT IS ORIENTED TOWARD USE IN ADVANCED GAS TURBINE ENGINES, THE GREATEST EFFORTS ARE GEARED TOWARD INCREASING USE TEMPERATURES FOR SUCH ENGINE COMPONENTS AS FAN BLADES, COMPRESSOR BLADES, TURBINE BUCKETS, AND NOZZLE VANES. TO ACHIEVE THESE OBJECTIVES, NEW COMPOSITE MATERIALS OF BOTH PLASTIC AND METAL MATRICES ARE BEING PRODUCED. CHEMICAL SYNTHESIS OF HIGH STRENGTH-HIGH TEMPERATURE PLASTIC OR POLYMER MATRIX MATERIALS AND METALLURGICAL ALLOYING OF METAL MATRIX MATERIALS ARE UNDERWAY CONCURRENTLY WITH STUDIES TO INCREASE STRENGTH OF FIBERS, BONDING OF FIBERS TO DIFFERENT TYPES OF MATRICES, AND COMPATIBILITY BETWEEN FIBER AND MATRIX. METHODS FOR DESIGNING AND ANALYZING FILAMENTARY COMPOSITES AND FOR STRUCTURAL SYNTHESIS OF GAS TURBINE COMPONENTS WITH OPTIMIZED PROPERTIES ARE BEING DEVELOPED. IMPLICIT IN EACH RESEARCH AREA ARE FUNDAMENTAL STUDIES TO RELATE PROPERTIES OF COMPOSITES TO PROPERTIES OF THEIR CONSTITUENTS UNDER DIFFERENT CONDITIONS OF STRESS APPLICATION, TEMPERATURE, AND ENVIRONMENTS.

RTOP NO. 129-03-23 TITLE: COMPOSITE MATERIALS

ORGANIZATION: NASA HEADQUARTERS

MONITOR: GANGLER, J. J. TEL. 202-962-0054

TECHNICAL SUMMARY

SEVERAL NEW HIGH MODULUS AND HIGH STRENGTH GLASS FIBER COMPOSITIONS WILL BE STUDIED FOR THEIR BEHAVIOR IN POLYMERIC MATRICES. THIS MAY LEAD TO A NEW FAMILY OF REINFORCED PLASTICS. DIRECTIONAL SOLIDIFIED EUTECTIC ALLOYS WILL BE INVESTIGATED FOR THEIR POTENTIAL AS HIGH PERFORMANCE COMPOSITES. THE FRACTURE BEHAVIOR OF CARBON FIBER AND BORIDE COMPOSITES WILL ALSO BE STUDIED IN ORDER TO DETERMINE MEANS TO IMPROVE THEIR TOUGHNESS CHARACTERISTICS.

RTOP NO. 129-03-24 TITLE: BEARINGS, SEALS AND LUBRICANTS

ORGANIZATION: NASA HEADQUARTERS

MONITOR: MALTZ, J. TEL. 202-962-0054

TECHNICAL SUMMARY

A SYMPOSIUM WILL BE SUPPORTED FOR THE PURPOSE OF FOSTERING INTERDISCIPLINARY DIALOGUE AND SUBSEQUENT RESEARCH ON THIS SUBJECT OF FRICTION AND WEAR.

RTOP NO. 129-03-24 TITLE: BEARINGS, SEALS AND LUBRICANTS

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: ANDERSON, W. J. TEL. 216-433-6468

TECHNICAL SUMMARY

BASIC MATERIALS AND LUBRICANTS STUDIES AS WELL AS EXPERIMENTS AND ANALYSES WITH ACTUAL COMPONENTS IN VACUUM, CRYOGENIC, INERT GAS, AND LOW VISCOSITY FLUID ENVIRONMENTS WILL BE CONDUCTED. MATERIALS STUDIES INCLUDE ATOMIC, MOLECULAR AND CRYSTALLINE AND SURFACE PHYSICS AND CHEMISTRY CONSIDERATIONS. THE POTENTIALS OF SELF-LUBRICATING MATERIALS AND FILM DEPOSITION METHODS ARE BEING EXPLORED. EXPERIMENTS AND ANALYSES OF PROMISING TYPES OF FLUID FILM BEARINGS

AND SEALS FOR GAS AND LOW VISCOSITY LIQUID APPLICATIONS ARE UNDERWAY. SEAL CONCEPTS INCLUDE THOSE WITH SELF-ACTING AND EXTERNALLY PRESSURIZED FILM GENERATION AND SELF-PUMPING VISCO SEALS. PROMISING MATERIALS FROM VACUUM STUDIES WILL BE USED FOR HUMAN HIP PROSTHESIS STUDIES AND POSSIBLE IMPLANTS. RESPONSE AND STABILITY ANALYSES OF FLEXIBLE ROTOR-BEARING SYSTEMS ARE BEING CONDUCTED TO ESTABLISH DESIGN TECHNOLOGY FOR FUTURE HIGH SPEED TURBOMACHINERY.

RTOP NO. 129-03-25 TITLE: EXTRATERRESTRIAL MATERIALS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: GANGLER, J. J. TEL. 202-962-0054
TECHNICAL SUMMARY

THIS WORK IS BEING CARRIED OUT BY THE BUREAU OF MINES UNDER A MULTIDISCIPLINARY GRANT. IT INVOLVES A COMPREHENSIVE PROGRAM OF BASIC RESEARCH ON THE PROPERTIES AND BEHAVIOR OF ROCKS AND MINERALS, SO THAT KNOWLEDGE WILL BE AVAILABLE WHEN NEEDED FOR THE DEVELOPMENT OF EXTRATERRESTRIAL MINING AND PROCESSING TECHNOLOGY. A SECOND PROJECT, TO DETERMINE THE ADHESION MECHANISMS FOR CLEAVED SILICATES, WILL BE COMPLETED IN FY 1970.

RTOP NO. 129-03-25 TITLE: EXTRATERRESTRIAL MATERIALS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

A STUDY OF THE BASIC MODES OF HEAT TRANSFER IN PARTICULATE MATERIALS WILL BE MADE. THE PROPERTIES OF THE LUNAR SURFACE MATERIAL AS REPORTED BY THE PRINCIPAL INVESTIGATORS OF THE APOLLO PROGRAM WILL BE COMPARED TO PROPERTIES OF THE SIMULATED LUNAR STUDIES CONDUCTED IN THE LABORATORY. PHYSICAL PROPERTIES AND ENGINEERING BEHAVIOR OF MATERIALS UNDER VARIOUS SIMULATED LUNAR AND PLANETARY ENVIRONMENTAL CONDITIONS WILL BE INVESTIGATED. THESE INVESTIGATIONS ARE NEEDED IN ORDER TO DEVELOP AND BUILD SKILL IN INTERPRETATION OF FINDINGS, KNOWLEDGE OF THE UNKNOWN, AND A MODE OF OPERATION AS RELATED TO EXTRATERRESTRIAL SOURCE MATERIALS.

RTOP NO. 129-03-25 TITLE: EXTRATERRESTRIAL MATERIALS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO OBTAIN AN INCREASED UNDERSTANDING OF THE EFFECTS OF SHOCK WAVES ON NATURAL CRYSTALLINE MATERIALS. RESULTS WILL BE OF VALUE IN LEADING TO A FULLER UNDERSTANDING OF THE MECHANISMS BY WHICH DIFFERENT CRYSTALLINE STRUCTURES DEFORM AND COLLAPSE UNDER SUDDENLY APPLIED LOADS. THE RESULTS OF THE STUDY WILL FIND IMMEDIATE APPLICATION IN THE ANALYSIS AND INTERPRETATION OF LUNAR MATERIALS.

RTOP NO. 129-03-26 TITLE: ADVANCED FORMING AND PROCESSING
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: PILTCH, A. TEL. 301-982-5053
TECHNICAL SUMMARY

CHEMICAL VAPOR DEPOSITION, ION BEAM POLISHING, ELECTROPOLISHING AND HIGH ENERGY FORMING ARE BEING INVESTIGATED AS METHODS FOR ACHIEVING HIGHLY ACCURATE AND STABLE DEVICES, PARTICULARLY FOR OPTICAL APPLICATIONS. THE EFFECTS OF SURFACE FINISH TREATMENTS ON THE STRENGTH OF CERAMIC MATERIALS ARE BEING STUDIED WITH A VIEW TO IMPROVING MECHANICAL PROPERTIES. LIGHT WEIGHT ALLOYS, METAL MATRIX AND POLYMERIC MATRIX MATERIALS ARE BEING STUDIED FOR USE AS STRUCTURAL MATERIALS FOR AEROSPACE APPLICATIONS IN GENERAL AND FOR SUPPORTING INSTRUMENT ELEMENTS IN PARTICULAR. THE PIEZOELECTRIC EFFECT IS BEING INVESTIGATED SPECIFICALLY AS A POSITIONING METHOD FOR GENERATING AND TESTING ACCURATE ASPHERIC OPTICAL ELEMENTS AND, IN GENERAL, FOR POSITIONING AND CONTROLLING INSTRUMENT LOCATIONS IN SPACE. COMPOSITION AND PROCESSING OF BRUSH MATERIALS ARE BEING INVESTIGATED FOR MAJOR LIFE IMPROVEMENT IN VARIOUS MEDIA.

RTOP NO. 129-03-26 TITLE: ADVANCED FORMING AND PROCESSING
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1119
TECHNICAL SUMMARY

THE MATERIALS PROCESSING AND MANUFACTURING IN SPACE PROGRAM PLAN IS AN INTERDISCIPLINARY EFFORT IN THE AREAS OF 1) MATERIALS SCIENCE, 2) MANUFACTURING TECHNOLOGY CULMINATING IN THE ADVANCEMENT OF MATERIALS SCIENCE AND THE PRODUCTION OF VALUABLE ITEMS IN EARTH ORBIT, AND 3) INDUSTRIAL APPLICATION. THIS RTOP RELATES TO THE MATERIALS SCIENCE ASPECT OF THE TOTAL PROGRAM AND IS PRESENTLY FOUNDED ON GROUND BASED STUDIES, BOTH IN-HOUSE AND CONTRACTOR, TO IDENTIFY THE MECHANISMS ASSOCIATED WITH GRAVITY SENSITIVE PROCESSES. THE REPORT OF THE 1968 WINTER STUDY ON USES OF MANNED SPACE FLIGHT SAID, "THE INITIAL EMPHASIS SHOULD BE UPON RESEARCH TO UNDERSTAND HOW MATERIALS BEHAVE DURING ZERO-G PROCESSING AND TO IDENTIFY NEW MATERIALS AND FABRICATION METHODS TO BE USED LATER." A LOGICAL, WELL-PLANNED, COHERENT RESEARCH PROGRAM IS BEING INITIATED TOWARD THE UNDERSTANDING OF SPACE ENVIRONMENTAL EFFECTS ON BASIC MECHANISMS AS WELL AS THE CHARACTERIZATION OF MATERIALS AND THEIR PROCESSES. THIS EVOLUTIONARY PROGRAM HAS AS ITS BEGINNING, STUDIES TO, 1) ANALYZE THE ROLE OF GRAVITY ON SOLIDIFICATION AND CRYSTAL GROWTH, 2) ANALYTICALLY INVESTIGATE CRYSTAL WHISKER GROWTH IN A ZERO-G ENVIRONMENT, 3) DETERMINE PHASE CHANGE (SOLIDIFICATION) PROCESS TO DEFINE FUNDAMENTAL PARAMETERS MOST AFFECTED BY ZERO-G, 4) INVESTIGATE THE EFFECTS OF ZERO-G ON MATERIALS PROPERTIES, 5) DETERMINE MATERIALS DOSAGING PROBLEMS, 6) DEFINE POSITIONING, TRANSPORTING, SPIN, AND AGITATING DEVICES AND, 7) EVALUATE SEPARATION AND PURIFICATION TECHNIQUES. MSFC WILL ALSO, 1) CONDUCT A THEORETICAL INVESTIGATION OF GAS MANAGEMENT IN ZERO-G BY MATHEMATICAL MODELING AND, 2) CONDUCT DROP TOWER TESTS ON CANDIDATE MATERIALS FOR METALS FORMING AND SHAPING EXPERIMENTS.

RTOP NO. 129-03-28 TITLE: SURFACE REACTIONS AND PROTECTION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: AULT, G. M. TEL. 216-433-6387
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE TO IDENTIFY THE SURFACE REACTIONS THAT OCCUR IN THE HOT GAS ENVIRONMENT OF GAS TURBINE ENGINES AND IN LIQUID ALKALI METALS FOR ADVANCED SPACE POWER SYSTEMS, TO ASSESS THE EXTENT OF MATERIAL DEGRADATION RESULTING FROM THESE REACTIONS AND TO PROVIDE PROTECTION FROM SUCH REACTIONS. PROTECTION MAY TAKE THE FORM OF PROTECTIVE COATINGS OR MAY INVOLVE ALLOY OR ENVIRONMENTAL MODIFICATIONS THAT INHIBIT REACTION. BASIC STUDIES WILL BE CONDUCTED TO PROVIDE AN UNDERSTANDING OF CORROSION MECHANISMS IN ORDER TO GUIDE EXPERIMENTATION AIMED AT PROVIDING PROTECTION. FOR EXAMPLE, IN STUDIES OF THE HOT SALT STRESS CORROSION OF TITANIUM ALLOYS, THE ROLES OF ENVIRONMENTAL CONSTITUENTS SUCH AS HYDROGEN, WATER VAPOR AND HALOGENS WILL BE EXAMINED. IN OXIDATION STUDIES, THE MECHANISM BY WHICH OXIDES BECOME NON-PROTECTIVE WILL BE STUDIED. IN LIQUID METAL CORROSION STUDIES, THE ROLES OF INTERSTITIAL IMPURITIES AND GETTERING ELEMENTS WILL BE ELUCIDATED. WHERE APPLICABLE, PROTECTIVE COATINGS WILL BE APPLIED AND THEIR EFFECTIVENESS STUDIED AS A FUNCTION OF TEMPERATURE, TIME AND ENVIRONMENTAL CONSTITUENTS.

RTOP NO. 129-03-29 TITLE: RESIN-FIBER COMPOSITE STRUCTURE TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: KEMP, R. H. TEL. 216-433-4000
TECHNICAL SUMMARY

THE PRINCIPAL OBJECTIVE IS TO ADVANCE THE TECHNOLOGY OF RESIN-FIBER COMPOSITES FOR THE PURPOSE OF PROMOTING THEIR USE IN THE SHUTTLE SYSTEM. THE HIGH STRENGTH TO WEIGHT RATIOS AND THE HIGH MODULUS TO WEIGHT RATIOS OBTAINED THROUGH THE USE OF FIBERS SUCH AS CARBON, BORON, GLASS AND SPECIAL ORGANIC FIBERS OFFER CONSIDERABLE PROMISE FOR REDUCING THE STRUCTURAL WEIGHT OF THE SHUTTLE SYSTEM AND THUS INCREASING THE PAYLOAD. IT IS BELIEVED THAT THE RESIN-FIBER SYSTEMS CAN BE COST EFFECTIVE IN ACHIEVING THIS GOAL. TO ACHIEVE THIS GENERAL OBJECTIVE, VARIOUS SPECIFIC RESEARCH TASKS ARE TO BE PERFORMED THAT WILL PROVIDE IMPROVED ANALYTICAL METHODS FOR DESIGNING COMPOSITES, PROVIDE RESINS WITH BETTER PROCESSIBILITY AND IMPROVED STRENGTH AND COMPATIBILITY CHARACTERISTICS, PROVIDE REQUIRED INFORMATION RELATIVE TO PROBLEMS SUCH AS THERMAL FATIGUE, RESIDUAL STRESSES AND FLAW PROPAGATION, AND FINALLY TO PROVIDE DESIGN DATA FOR THE MORE PROMISING RESIN-FIBER SYSTEMS. RELATED IN-HOUSE WORK WILL BE CONDUCTED UNDER 129-03-23.

RTOP NO. 129-03-29 TITLE: STRUCTURAL COMPOSITE MATERIALS FOR SPACE SHUTTLE
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

COMPOSITE UTILIZING HIGH STRENGTH AND/OR HIGH MODULUS BORON, GRAPHITE, OR ORGANIC FIBERS OFFER POTENTIAL WEIGHT SAVINGS IN

STRUCTURAL COMPONENTS FOR AIRCRAFT AND SPACE VEHICLES. ALTHOUGH THESE ADVANCED HIGH STRENGTH FIBERS STILL ARE RELATIVELY EXPENSIVE, THE PRICE IS DECREASING WITH DEVELOPMENT EFFORTS AND INCREASED USAGE.

IT IS EXPECTED THAT IN THE NEAR FUTURE COMPOSITES MADE FROM THESE FIBERS WILL BE COST EFFECTIVE IN MANY AREAS. IN ORDER TO INCREASE OUR KNOWLEDGE OF THE POTENTIAL OF THESE MATERIALS, THE FOLLOWING EFFORTS SHOULD BE STUDIED: 1. EVALUATION OF BORON-ALUMINUM COMPOSITE SHEET AND SHAPES FOR STRUCTURAL APPLICATION. 2. DEVELOPMENT OF HIGH MODULUS ORGANIC FIBER COMPOSITES. 3. DEVELOPMENT OF A GRAPHITE FIBER REINFORCED HONEYCOMB CORE MATERIAL.

RTOP NO. 129-03-30 TITLE: REFRACTORY METAL HEAT SHIELDS FOR SPACE SHUTTLE VEHICLES

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: AULT, G. M. TEL. 216-433-4000

TECHNICAL SUMMARY

THIS PROGRAM INVOLVES RESEARCH AND DEVELOPMENT ON COATED COLUMBIUM AND TANTALUM ALLOYS FOR USE AT TEMPERATURES IN THE RANGE 2000 DEGREES TO 2700 DEGREES F IN THE HEAT SHIELDS OF RE-ENTRY VEHICLES. EMPHASIS IS PLACED ON PROVIDING THE TECHNOLOGY TO MEET THE MULTI-MISSION, MINIMUM REFURBISHMENT REQUIREMENTS OF THE SPACE SHUTTLE. INITIAL EFFORT WILL BE DEVOTED TO IDENTIFYING THE MOST PROMISING COATING-SUBSTRATE COMBINATIONS. EFFORTS TO IMPROVE COATING PROTECTION AND RELIABILITY WILL BE SUPPORTED BY THE DEVELOPMENT OF IMPROVED COATING COMPOSITIONS, PROCESS SCALE-UP AND QUALITY CONTROL, AND EVALUATION OF THE EFFECTS OF THE COATING ON THE MECHANICAL PROPERTIES OF THE SUBSTRATE. THE STUDIES WILL BE CARRIED TO THE POINT OF LABORATORY EVALUATION OF COATED TEST SPECIMENS AND MINIATURE HEAT SHIELD PANELS UNDER PARTIALLY SIMULATED RE-ENTRY CONDITIONS. THE PROGRAM WILL DEVELOP THE NECESSARY COATING TECHNOLOGY BUT WILL NOT PRODUCE OR EVALUATE FULL-SCALE HARDWARE. THE DESIGN AND TESTING OF HEAT SHIELD PANELS UNDER CLOSELY SIMULATED, HIGH VELOCITY RE-ENTRY CONDITIONS IS THE RESPONSIBILITY OF THE LANGLEY RESEARCH CENTER.

RTOP NO. 129-03-31 TITLE: DEVELOPMENT OF NI-CR-THO2 FOR SPACE SHUTTLE VEHICLES

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: AULT, G. M. TEL. 216-433-4000

TECHNICAL SUMMARY

THIS PROGRAM INVOLVES THE DEVELOPMENT OF THE DISPERSION STRENGTHENED NICKEL-CHROMIUM ALLOY (NI-CR-THO2) FOR USE IN THE HEAT SHIELD OF PROPOSED SPACE SHUTTLE VEHICLES. THE OBJECTIVES OF THE PROGRAM ARE: 1. TO ASSURE THAT NI-CR-THO2 IS THE BEST MATERIAL AND MEETS ALL THE REQUIREMENTS FOR THIS APPLICATION. 2. TO IMPROVE AND SCALE-UP PRESENT METHODS OF PRODUCING NI-CR-THO2 SHEET TO ATTAIN BETTER QUALITY, MORE CONSISTANT PROPERTIES, BETTER OXIDATION RESISTANCE, AND LARGER SHEET SIZES. 3. TO DEVELOP RELIABLE METHODS FOR FORMING AND JOINING NI-CR-THO2 SHEET INTO HEAT SHIELD CONFIGURATIONS. 4. TO DEVELOP AN ALTERNATE PROCESS FOR PRODUCING NI-CR-THO2. THE WORK REQUIRED TO MEET THESE OBJECTIVES WILL BE DONE

PRIMARILY THROUGH CONTRACTS WITH QUALIFIED INDUSTRIAL LABORATORIES. THE SCOPE OF THE PROGRAM IS LIMITED TO MEETING THE STATED OBJECTIVES. THE PROGRAM IS DESIGNED TO ASSURE THAT THE MATERIAL AND NECESSARY TECHNOLOGY WILL BE AVAILABLE FOR THE FABRICATION OF ACTUAL VEHICLE HEAT SHIELDS. IT DOES NOT INCLUDE FABRICATION OF THE ACTUAL VEHICLE HEAT SHIELDS, OR RE-ENTRY SIMULATION TESTING OF FULL SIZE HEAT SHIELD PANELS IN HIGH VELOCITY AIR.

RTOP NO. 129-03-32 TITLE: BEARING AND LUBRICANT TECHNOLOGY FOR
SPACE APPLICATIONS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PLAN IS TO PROVIDE SOLUTIONS TO THE PROBLEMS OF LUBRICATING BEARING SYSTEMS AND OTHER COMPONENTS FOR LONG LIFETIMES IN THE VARIETY OF ENVIRONMENTS WHICH WILL BE ENCOUNTERED BY SHUTTLE SPACECRAFT. EARLY ORBITAL FLIGHTS OF BOTH SATELLITES AND MANNED SPACECRAFT HAVE HAD LUBRICATION SYSTEMS THAT WERE EITHER COMPLETELY SEALED OR THAT HAD RELATIVELY SHORT LIFE REQUIREMENTS. EVEN SUCH SPACECRAFT AS THE APOLLO TELESCOPE MOUNT AND THE ORBITAL WORKSHOP HAVE LIMITED LIFE REQUIREMENTS WHICH ARE WITHIN THE PRESENT STATE-OF-THE-ART. IT IS INTENDED TO ACCOMPLISH THE ABOVE OBJECTIVE BY THE CONTINUED DEVELOPMENT OF FLUID AND DRY LUBRICANTS AND BY THE DEVELOPMENT OF SPECIAL DESIGNS FOR SLIDING AND ROLLING ELEMENTS WHICH WILL MEET THE LIFE AND ENVIRONMENTAL REQUIREMENTS POSED BY THESE ADVANCED SYSTEMS.

RTOP NO. 129-03-32 TITLE: FATIGUE, FRACTURE AND LIFE PREDICTION

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: AULT, G. M. TEL. 216-433-4000

TECHNICAL SUMMARY

A MAJOR OBJECTIVE IS TO OBTAIN A BETTER UNDERSTANDING OF THE FAILURE OR FRACTURE MECHANISMS THAT ARE INVOLVED IN THE APPLICATION OF ADVANCED MATERIALS TO AEROSPACE MISSIONS. A SECOND MAJOR OBJECTIVE IS TO DEVELOP METHODS FOR PREDICTING THE LIFE OF SPECIMENS AND COMPONENTS WHEN THEY ARE SUBJECTED TO COMPLEX PATTERNS OF TEMPERATURES AND LOADS AS A FUNCTION OF TIME. TO ACHIEVE THESE OBJECTIVES, RESEARCH IS UNDERWAY TO EXTEND EXISTING ANALYSES AND TO DEVELOP NEW APPROACHES FOR DETERMINING THE STRESS AND STRAIN DISTRIBUTIONS IN THE VICINITY OF DISCONTINUITIES SUCH AS FLAWS OR CRACKS, AND TO UNDERSTAND THE REACTION OF AEROSPACE MATERIALS TO THESE DISCONTINUITIES WHEN SUBJECTED TO VARIOUS ENVIRONMENTAL CONDITIONS. APPROACHES ARE ALSO BEING EXAMINED FOR PREDICTING THE TIME TO THE INITIATION OF THE FIRST DETECTABLE CRACKS AS A R AND TO PREDICTING THE PROPAGATION RATES OF MECHANICAL AND THERMAL FATIGUE OF THE CRACKS. EFFECTS OF CRYOGENIC AND ELEVATED TEMPERATURES ON THE FAILURE MECHANISMS ARE BEING STUDIED AS WELL AS THE EFFECT OF HIGH PRESSURE ON THE FLOW AND FRACTURE OF MATERIALS SUCH AS CHROMIUM. THIS PROGRAM COUPLES WITH OTHER IN-HOUSE AND CONTRACT WORK UNDER RTOP 126-15-16.

RTOP NO. 129-03-33 TITLE: MATERIALS COMPATIBILITY EVALUATION
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

OBJECTIVE: DURING THE DEVELOPMENT OF LARGE LAUNCH VEHICLES AND ASSOCIATED GROUND SUPPORT EQUIPMENT, THE USE OF MATERIALS WHICH ARE NOT COMPATIBLE WITH THE ENVIRONMENTAL CONDITIONS TO WHICH THEY HAVE BEEN EXPOSED HAS BEEN A CONTINUING PROBLEM. THIS HAS RESULTED IN PREMATURE MATERIAL FAILURES, LAUNCH DELAYS, AND INCREASED COSTS BECAUSE OF COMPONENT REPLACEMENT AND MATERIAL CHANGES. SINCE FUTURE DESIGNS SUCH AS THE SPACE SHUTTLE ARE EXPECTED TO HAVE CONSIDERABLY LONGER OPERATING LIVES AND THE OPERATING CONDITIONS REQUIRE THE USE OF NEW HIGH TEMPERATURE MATERIALS AS WELL AS SUBJECTING WELL KNOWN MATERIALS TO UNUSUAL ENVIRONMENTAL CONDITIONS, A VERY CAREFUL EVALUATION OF MATERIAL COMPATIBILITY WITH EXPECTED EXPOSURE CONDITIONS IS REQUIRED. IN ADDITION TO CORROSION AND STRESS CORROSION ENVIRONMENT SUPERIMPOSED ON THE SPACE AND RE-ENTRY ENVIRONMENTS, CERTAIN OF THE METALS AND ALLOYS WILL BE EXPOSED TO HIGH-PRESSURE OXYGEN. FINALLY, LOX AND GOX COMPATIBILITY OF NONMETALLIC MATERIALS WITH PARTICULAR REFERENCE TO FLAMMABILITY OF ORGANIC MATERIALS IS A MAJOR AND CONTINUING PROBLEM. IN THE PAST, MUCH EFFORT HAS BEEN PUT INTO CORROSION AND STRESS CORROSION RESISTANCE, BUT WORK ON NEWER ALLOYS AND THE NEW COMBINATION OF ENVIRONMENTS IS ESSENTIAL. RESEARCH ON HYDROGEN EMBRITTLEMENT IS AT A RELATIVELY PRIMITIVE STATE AND WILL REQUIRE MORE CONCENTRATED EFFORT BECAUSE THE SHUTTLE WILL BE THE FIRST APPLICATION OF HIGH PRESSURE HYDROGEN FLIGHT SYSTEMS. WHILE MUCH PAST EFFORT HAS BEEN DIRECTED TO LOX AND GOX EXPLOSION AND FLAMMABILITY, MORE NEEDS TO BE DONE.

RTOP NO. 129-03-40 TITLE: SURFACE PHYSICS AND CHEMISTRY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: NASH, R. R. TEL. 202-962-6891
TECHNICAL SUMMARY

THIS RESEARCH SEEKS INCREASED FUNDAMENTAL UNDERSTANDING OF THE RELATIONSHIP BETWEEN ELECTRONIC AND ATOMIC STRUCTURE OF SOLIDS AND THEIR PHYSICAL, CHEMICAL AND MECHANICAL SURFACE BEHAVIOR. SPECIFIC SURFACE-CONTROLLED MATERIALS PROPERTIES OF INTEREST ARE ELECTRON AND ION EMISSION, SEMICONDUCTOR SURFACE BEHAVIOR, NUCLEATION AND GROWTH OF THIN FILMS AND CRYSTALS, ADSORPTION, EVAPORATION, OXIDATION, CORROSION, FRICTION AND WEAR AND INITIATION OF FRACTURE. THE OVERALL GOAL IS TO OBTAIN BETTER UNDERSTANDING OF MECHANISMS OF BEHAVIOR FOR IMPROVED TECHNICAL CONTROL OVER INTERFACIAL REACTIONS IN MATERIALS OF IMPORTANCE IN AERONAUTICS AND SPACE.

RTOP NO. 129-03-40 TITLE: SURFACE PHYSICS AND CHEMISTRY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THIS RESEARCH INCLUDES THEORETICAL AND EXPERIMENTAL STUDIES OF

THE PHYSICAL, MECHANICAL, AND ELECTRONIC PROPERTIES OF SURFACES. THESE STUDIES RANGE FROM MEASUREMENTS OF SURFACE ENERGIES WITH A PRECISION, LIQUID-NITROGEN BOILOFF CALORIMETER AND CHARACTERIZATION OF THE INTERACTIONS OF GASES AND SURFACES WITH A SURFACE-ION MASS SPECTROMETER TO ATTEMPTS TO GAIN UNDERSTANDING OF THE KINETICS OF NUCLEATION AND GROWTH OF CRYSTAL NUCLEI WITH IN SITU ULTRAHIGH-VACUUM ELECTRON MICROSCOPY. RESULTS OF THIS WORK WILL HAVE APPLICATION IN SUCH AREAS AS ELECTRONICS, CORROSION PREVENTION, AND MATERIALS PROCESSING.

RTOP NO. 129-03-40 TITLE: SURFACE PHYSICS AND CHEMISTRY
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

THEORETICAL AND EXPERIMENTAL STUDIES ARE BEING PERFORMED IN ORDER TO AUGMENT THE UNDERSTANDING OF VARIOUS ATOMIC, IONIC AND ELECTRONIC INTERACTIONS AT GAS-SOLID INTERFACES. THESE INVESTIGATIONS HAVE TAKEN ADVANTAGE OF LOW ENERGY ELECTRON DIFFRACTION (LEED), AUGER ELECTRON SPECTROSCOPY (AES), FIELD EMISSION (FEM) AND FIELD ION MICROSCOPY (FIM) METHODS TOGETHER WITH OTHER EFFECTIVE AND SIGNIFICANT MEASUREMENTS SUCH AS WORK FUNCTION, PRESSURE INCREASE DURING FLASH FILAMENT DESORPTION, ETC. DURING LAST YEAR, SPECIAL EMPHASIS WAS MADE ON STUDIES OF NICKEL SURFACES WITH LEED. SURFACE DEBEYE TEMPERATURES (DEBEYE WALLER FACTOR) WERE MEASURED AND PUBLISHED IN A PAPER. A NEW METHOD OF PREPARING LEED TARGETS (SINGLE SPHERICAL CRYSTALS IN VITRO) OF COPPER, NICKEL AND SILVER FROM CRYSTALLINE SAMPLES HAS BEEN DEVELOPED. NEW AND IMPROVED APPARATUS HAS BEEN CONSTRUCTED THAT ENABLES COLD WELDING AND FRICTION MEASUREMENTS ALONG CERTAIN CRYSTALLOGRAPHIC DIRECTIONS UNDER CONTROLLED CONDITIONS, I. E., SURFACE CLEANNESS AND CRYSTAL ORIENTATION.

RTOP NO. 129-03-41 TITLE: THIN FILMS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: WEINBERG, I. TEL. 202-963-3924
TECHNICAL SUMMARY

THIS RESEARCH SEEKS INCREASED UNDERSTANDING OF THE BASIC MECHANISMS OF GROWTH AND DETERIORATION AND THE FUNDAMENTAL RELATIONSHIPS BETWEEN STRUCTURE AND ELECTRONIC PROPERTIES OF THIN FILMS. INFORMATION OBTAINED FROM THIS PROGRAM WILL CONTRIBUTE SIGNIFICANTLY TOWARDS ACHIEVING MORE EFFICIENT OPERATION OF ELECTRONIC DEVICES BASED ON THIN FILM TECHNOLOGY. INVESTIGATIONS ARE CONDUCTED, AIMED AT UNDERSTANDING THE BASIC MECHANISMS OF ELECTRON AND MATTER TRANSPORT IN THIN FILMS AND THE RELATIONSHIPS BETWEEN FILM STRUCTURE AND TRANSPORT PROPERTIES. MECHANISMS OF FILM DETERIORATION ARE INVESTIGATED AN EXAMPLE BEING THE PHENOMENA OF FAILURE INDUCING VOID FORMATION DUE TO ELECTROTRANSPORT AT HIGH CURRENT DENSITIES. FILMS ARE CHARACTERIZED WITH RESPECT TO IMPURITIES CRYSTAL STRUCTURE, IMPERFECTIONS AND SIZE TO PROVIDE DETAILED INFORMATION FOR USE IN RELATING TRANSPORT PHENOMENA TO THIN FILM PROPERTIES. MECHANISMS OF

FILM GROWTH ARE INVESTIGATED IN ORDER TO IMPROVE PERFORMANCE AND ATTAIN INCREASED PERFECTION IN THIN FILMS.

RTOP NO. 129-03-41 TITLE: THIN FILM RESEARCH
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THIS RESEARCH INCLUDES EXPERIMENTAL AND THEORETICAL STUDIES OF THE BASIC MECHANISM OF THE GROWTH AND STABILITY OF EPITAXIAL, POLYCRYSTALLINE, AND AMORPHOUS THIN FILMS. HIGH- AND LOW-ENERGY ELECTRON DIFFRACTION, AUGER ELECTRON SPECTROSCOPY, AND HIGH RESOLUTION ELECTRON MICROSCOPY WILL BE USED FOR IN-SITU STUDIES OF STRUCTURE-SENSITIVE DEPOSITION PARAMETERS OF THIN FILMS IN GENERAL - SUCH AS, FOR EXAMPLE, FILMS FOR OPTICAL, CORROSION-PROTECTIVE, OR ELECTRONIC APPLICATIONS.

RTOP NO. 129-03-42 TITLE: PHYSICS AND CHEMISTRY OF SOLIDS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: NASH, R. R. TEL. 202-962-6891
TECHNICAL SUMMARY

THIS RESEARCH SEEKS INCREASED SCIENTIFIC UNDERSTANDING OF THE BASIC PROPERTIES OF MATERIALS OF STRUCTURAL AND ELECTRONIC IMPORTANCE TO NASA MISSIONS. BROADLY-BASED ATTENTION IS GIVEN TO THE RELATIONSHIP BETWEEN ELECTRONIC, ATOMIC AND MOLECULAR STRUCTURE OF SOLIDS AND THEIR PHYSICAL, CHEMICAL AND MECHANICAL PROPERTIES. CURRENT RESEARCH EMPHASIZES INVESTIGATION OF ATOMIC BONDING, CRYSTAL DEFECT STRUCTURE, THERMODYNAMICS AND KINETICS OF SOLID STATE REACTIONS, DIFFUSION, PHASE TRANSFORMATIONS, MECHANICAL PROPERTIES AND STRENGTHENING MECHANISMS AND ENVIRONMENT-SENSITIVE BEHAVIOR OF MATERIALS. NEW KNOWLEDGE FROM THESE STUDIES WILL CONTRIBUTE TO THE DESIGN OF NEW MATERIALS AND TO THE IMPROVEMENT OF EXISTING ONES FOR APPLICATIONS IN AERONAUTICS AND SPACE TECHNOLOGY.

RTOP NO. 129-03-42 TITLE: PHYSICS & CHEMISTRY OF SOLIDS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: LAD, R. A. TEL. 216-433-4000
TECHNICAL SUMMARY

OBJECTIVE: TO OBTAIN AN INCREASED UNDERSTANDING OF THE BASIC PROPERTIES OF THE SOLID STATE, BOTH BULK AND SURFACE, WITH PARTICULAR EMPHASIS ON THE ROLE OF ELECTRONIC AND MAGNETIC PROPERTIES, ATOMIC STRUCTURE AND CHEMICAL REACTIVITY IN THE DETERMINATION OF PHYSICAL, CHEMICAL AND MECHANICAL PROPERTIES. THE PARTICULAR ASPECTS OF THE RESEARCH ARE DESIGNED TO APPLY TO MATERIALS PREPARATION AND TO THE CONTROL OF PHYSICAL PHENOMENA IN MATERIALS OF STRUCTURAL AND ELECTRONIC IMPORTANCE TO NASA. APPROACH: PROGRAMS PERTINENT TO DIFFUSION CONTROLLED PHENOMENA SUCH AS MECHANICAL DEFORMATION, THERMAL STABILITY AND RADIATION DAMAGE WILL INCLUDE THEORETICAL AND EXPERIMENTAL STUDIES OF DIFFUSION AND THE DEFECT STRUCTURE IN METALS,

INTERNAL FRICTION AND RESISTIVITY STUDIES OF RADIATION DAMAGED METALS, AND STUDIES OF THE NATURE OF SURFACE DEFECTS USING TECHNIQUES SUCH AS EPR, GAS ABSORPTION AND ELECTRON BOMBARDMENT. PROGRAMS WHICH APPLY TO PHENOMENA RELATED TO ELECTRONIC AND MAGNETIC PROPERTIES WILL INCLUDE DEVELOPMENT OF MAGNETIC THEORY FOR PURE METALS AND ALLOYS, AND THE MEASUREMENT OF MAGNETIC PROPERTIES USING TECHNIQUES SUCH AS MAGNETIC SUSCEPTIBILITY, MAGNETOSTRICTION, NEUTRON DIFFRACTION AND MOSSBAUER SPECTROSCOPY. PROGRAMS PERTINENT TO CHEMICAL BOND CONTROLLED PROPERTIES SUCH AS THERMAL AND HIGH VACUUM STABILITY, HYDROGEN EMBRITTLEMENT IN METALS, ELECTRICAL STABILITY OF INSULATORS AT HIGH TEMPERATURE AND METAL PURITY WILL INCLUDE MASS SPECTROMETRIC STUDIES OF HIGH TEMPERATURE DECOMPOSITION OF REFRACTORY COMPOUNDS, ELECTRICAL CONDUCTIVITY AND DIFFUSION STUDIES IN HIGH TEMPERATURE ELECTRICAL INSULATORS, EPR STUDIES OF INTERACTION OF OXYGEN WITH METAL AND OXIDE SURFACES, ELECTRICAL RESISTIVITY AND MECHANICAL PROPERTIES DETERMINATIONS ON HYDROGEN LOADED TITANIUM, AND STUDIES OF HIGH PURITY METAL PREPARATION BY THE USE OF HIGH ENERGY ELECTRON IRRADIATION OF SOLUTIONS.

RTOP NO. 129-03-42 TITLE: PHYSICS AND CHEMISTRY OF SOLIDS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO OBTAIN AN INCREASED UNDERSTANDING OF INFLUENCE OF EARTH, PLANETARY, AND INTERPLANETARY ENVIRONMENTS ON THE DEGRADATION OF MATERIALS. RESULTS OF THIS WORK WILL BE USEFUL IN THE DESIGN OF AIRCRAFT AND SPACECRAFT.

RTOP NO. 129-03-43 TITLE: PROPERTIES OF MATERIALS FOR ELECTRONIC APPLICATIONS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

EXPERIMENTAL AND THEORETICAL STUDIES ARE CONDUCTED ON THE RELATIONSHIP BETWEEN THE ATOMIC, MOLECULAR, AND MORPHOLOGICAL STRUCTURE OF MATERIALS AND THEIR ELECTRONIC PROPERTIES. IN THESE STUDIES, DATA ARE ACQUIRED ON SEMICONDUCTORS AND DIELECTRIC AND FERROMAGNETIC MATERIALS WHICH WILL BE OF USE IN THE DESIGN OF NEW DEVICES AND COMPONENTS HAVING STABILITIES AND LIFETIMES CONSISTENT WITH PRESENT AND FUTURE MISSION REQUIREMENTS. OF NECESSITY, STUDIES OF THE PROPERTIES FOR ELECTRONIC APPLICATIONS COVER A WIDE RANGE OF DISCIPLINES AND APPROACHES. THEY INCLUDE DETERMINATION OF THE INFLUENCE OF ELECTROMAGNETIC AND LASER RADIATION ON ION-IMPLANTED AND DIFFUSION-DOPED CRYSTALS, INQUIRY INTO CHARGE TRANSPORT PHENOMENA IN POLYMERS, AND INVESTIGATION OF THE EFFECTS OF ALLOY STOICHIOMETRY AND GRAIN BOUNDARY INTERACTIONS ON THE BEHAVIOR OF DIELECTICS.

RTOP NO. 129-03-43 TITLE: PROPERTIES OF MATERIALS FOR ELECTRONIC APPLICATIONS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G.

TEL. 205-453-1120

TECHNICAL SUMMARY

THEORETICAL AND EXPERIMENTAL STUDIES ARE USED TO BETTER UNDERSTAND THE EFFECTS OF ELECTROMAGNETIC AND PARTICULATE IRRADIATION ON THE OPTICAL ELECTRONIC AND MAGNETIC PROPERTIES OF INORGANIC SEMICONDUCTORS. THE NEED FOR A BETTER DEFINITION OF THE DAMAGE MECHANISMS AND THE FORMULATION OF A MODEL TO INDICATE DAMAGE AND IMPURITY SITE WITHIN THE CRYSTALS IS IMPERATIVE AS THESE MATERIALS ARE USED ON ALMOST ALL SPACE PAYLOADS.

RTOP NO. 129-03-43 TITLE: PROPERTIES OF MATERIALS FOR ELECTRONIC APPLICATIONS

ORGANIZATION: NASA HEADQUARTERS

MONITOR: WEINBERG, I.

TEL. 202-963-3924

TECHNICAL SUMMARY

THIS RESEARCH IS AIMED AT DETERMINING THE BASIC RELATIONSHIPS BETWEEN ELECTRONIC AND DEFECT STRUCTURES OF MATERIALS AND THEIR POTENTIALLY USEFUL ELECTRONIC PROPERTIES. INCREASED UNDERSTANDING IS SOUGHT IN ORDER TO DETERMINE THE BEST DIRECTIONS TO FOLLOW IN OBTAINING IMPROVED EXISTING, AND NEW, MATERIALS FOR ELECTRONIC APPLICATIONS. EXPERIMENTAL AND THEORETICAL STUDIES OF ELECTRONIC STRUCTURE, DEFECT STATES AND TRANSPORT, MAGNETIC, SUPERCONDUCTING, DIELECTRIC, SEMICONDUCTING AND INSULATING PROPERTIES ARE UTILIZED IN OBTAINING AN UNDERSTANDING OF MATERIALS FOR USE IN ELECTRONIC DEVICES. EMPHASIS IS GIVEN TO STUDIES ON MATERIALS PREPARED IN SINGLE CRYSTAL, POLYCRYSTALLINE AND AMORPHOUS FORMS. AN UNDERSTANDING OF MATERIALS GROWTH PARAMETERS IS RELATED TO ELECTRONIC PROPERTIES IN BOTH IMPROVED AND NEW MATERIALS.

RTOP NO. 129-04-20 TITLE: BASIC APPLIED MATHEMATICS

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: HALL, J. H.

TEL. 216-433-4000

TECHNICAL SUMMARY

IT IS THE OBJECTIVE OF THIS WORK TO IMPROVE THE EFFICIENCY AND EFFECTIVENESS OF SOLVING ANALYTICAL PROBLEMS AND PROCESSING EXPERIMENTAL DATA BY USE OF IMPROVED TECHNIQUES IN APPLIED MATHEMATICS AND NUMERICAL ANALYSIS. COMPUTER OPERATING SYSTEMS (SOFTWARE) DEVELOPMENT WILL EMPHASIZE DIRECT MAN/MACHINE INTERACTION TO TAKE MAXIMUM ADVANTAGE OF AVAILABLE COMPUTER HARDWARE. THIS APPROACH TO SHORTENING THE COMMUNICATION LINK BETWEEN THE SCIENTIST AND THE PROBLEM SOLVING PROCESS IN LARGE COMPUTERS OFFERS SUBSTANTIAL GAINS IN PRODUCTIVITY OF THE SCIENTIST.

RTOP NO. 129-04-20 TITLE: MATHEMATICS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

ONE BASIC CONCEPT OF ADEQUATELY MANAGING THIS FLOOD OF INFORMATION IS ESTABLISHED AS "DATA DISCRIMINATION", WHICH CONSISTS OF THE STRICT SEPARATION OF THE SIGNIFICANT FROM THE "EMPTY" INFORMATION. THIS CONCEPT RESULTS IN PARAMETERIZATION OF THE PHYSICAL PROCESSES MONITORED IN THE SPACECRAFT VERSUS THE CONVENTIONAL TREATMENT OF MOSTLY UNDETERMINED TIME SERIES OF DATA. FOR THIS CONCEPT, SPECIFIC AND COMPUTER ECONOMIZING ANALYTICAL MODELS AND PARAMETER-BASED ALGORITHMS HAVE TO BE DEVELOPED. THE TASKS WITH PREFERENTIAL RELEVANCE TO THE INFORMATION-MANAGEMENT PROBLEM COMPRISE THE FOLLOWING: A. REPRESENTATIVENESS OF NONSTATIONARY TIME-VARIABLES. B. STATISTICAL ANALYSIS OF NON-REGULAR PARAMETER-DISTRIBUTIONS. C. APPLICATION OF MONTE CARLO METHODS TO THE SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS. D. ALGORITHMS FOR THE SOLUTION OF NONLINEAR MATHEMATICAL PROGRAMMING PROBLEMS. E. AUTOMATIC MODELING AND PARAMETER ANALYSIS OF PHYSICAL SYSTEMS BY MEANS OF HYBRID COMPUTER.

RTOP NO. 129-04-20 TITLE: MATHEMATICS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: ROSENFELD, S. A. TEL. 202-962-0568
TECHNICAL SUMMARY

THE GENERAL OBJECTIVE OF THIS PROGRAM IS TO ENCOURAGE THE DEVELOPMENT OF ANALYTICAL, STATISTICAL, AND NUMERICAL TECHNIQUES OF POTENTIAL VALUE TO NASA SCIENTISTS AND ENGINEERS. MATHEMATICAL RESEARCH AREAS TO BE EMPHASIZED ARE: ANALYSIS AND GEOMETRY; PROBABILITY THEORY AND MATHEMATICAL STATISTICS; COMPUTATIONAL AND NUMERICAL ANALYSIS; MODERN CONTROL THEORY AND OPTIMIZATION TECHNIQUES; AND OPERATIONS RESEARCH AND SYSTEMS ANALYSIS. SPECIFIC OBJECTIVES OF THE HEADQUARTERS' MATHEMATICS PROGRAM ARE (1) TO COMPLEMENT THE MORE APPLIED RESEARCH BEING DONE AT THE NASA CENTERS WITH FUNDAMENTAL MATHEMATICAL RESEARCH TYPICALLY FOUND IN THE UNIVERSITY ENVIRONMENT AND (2) TO PROVIDE AN EFFECTIVE AVENUE FOR COMMUNICATION BETWEEN THE CENTER AND UNIVERSITY RESEARCHERS IN AREAS OF COMMON INTEREST. THOSE ASPECTS OF MATHEMATICAL RESEARCH WHICH ARE CLEARLY RELEVANT TO THE NEEDS OF OUR RESEARCHERS IN THE PHYSICAL, ENGINEERING ENVIRONMENTAL, AND LIFE SCIENCES WILL BE SPONSORED.

RTOP NO. 129-04-20 TITLE: MATHEMATICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO PURSUE RESEARCH IN BASIC APPLIED MATHEMATICS SUCH AS ANALYTICAL MECHANICS, DIFFERENTIAL EQUATIONS AND MANY APPLICATIONS TO PHYSICS. SPECIFICALLY, THIS WORK WILL BE CONCERNED WITH TECHNIQUES FOR SOLVING DIFFERENTIAL AND INTEGRAL EQUATIONS WITH EMPHASIS ON THE IDENTIFICATION OF CRITICAL

ITEMS AFFECTING ACCURACY AND EFFICIENCY, MAN-COMPUTER INTERACTIONS, AND INTERACTIVE COMPUTING TECHNIQUES. THIS WORK WILL FIND APPLICATION IN A WIDE RANGE OF PROBLEMS FOR WHICH DIGITAL COMPUTER SOLUTIONS WILL BE REQUIRED. ALSO THE WORK INVOLVING MAN-COMPUTER INTERACTIONS OFFERS PROMISE IN MAKING THE COMPUTER A MORE EFFICIENT AND EFFECTIVE AID IN PROBLEM SOLVING.

RTOP NO. 129-04-20 TITLE: MATHEMATICS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS RTOP ARE: (1) TO DO RESEARCH IN NUMERICAL ANALYSIS, WITH A VIEW TO DEVELOPING METHODS WHICH ARE MORE RELIABLE, INFORMATIVE AND EFFICIENT, PARTICULARLY FOR USE ON DIGITAL COMPUTERS; (2) TO CONDUCT RESEARCH IN CERTAIN SPECIFIC AREAS OF STATISTICAL ESTIMATION THEORY, STOCHASTIC PROCESSES, OPTIMAL CONTROL THEORY, PERTURBATION THEORY, APPLIED MATHEMATICS, AND RELATIVITY THEORY WHICH ARE SIGNIFICANT TO NASA/JPL PROBLEMS; (3) TO CONDUCT RESEARCH IN STATISTICAL ESTIMATION THEORY, STOCHASTIC PROCESSES AND NONLINEAR AND DYNAMIC PROGRAMMING; TO CONDUCT BASIC RESEARCH IN ADVANCED TECHNIQUES FOR THE GENERATION OF ANALYTIC AND LITERAL SOLUTIONS OF SYSTEMS OF NONLINEAR DIFFERENTIAL EQUATIONS OF BOTH THE INITIAL-VALUE AND BOUNDARY-VALUE TYPE; (4) TO DEVELOP AND APPLY NEW MATHEMATICAL TECHNIQUES FOR THE EXACT ANALYTICAL SOLUTION OF THE NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS WHICH ARISE IN GENERAL RELATIVITY. NUMERICAL ANALYSIS RESEARCH IS CURRENTLY CONCENTRATED IN THE AREAS OF LINEAR ALGEBRA, NON-LINEAR EQUATIONS, DIFFERENTIAL EQUATIONS, INTEGRAL EQUATIONS AND CONSTRUCTIVE REPRESENTATION OF SPECIAL FUNCTIONS. STATISTICAL ESTIMATION STUDIES ARE CONTINUING IN THE SEQUENTIAL ESTIMATION OF LINEAR AND NON-LINEAR CORRELATED STOCHASTIC VARIABLES ASSOCIATED WITH NON-STATIONARY RANDOM PROCESSES, DATA COMPRESSION STUDIES AND STUDIES IN RECURSIVE UPDATING METHODS FOR ORBIT DETERMINATION PROBLEMS; EMPHASIS IS ON TECHNIQUES CAPABLE OF PERFORMING NON-LINEAR ESTIMATION IN NEAR REAL-TIME. THE TECHNIQUES EVOLVED IN THE INFORMATION THEORY SCIENCES WILL BE INVESTIGATED FOR THEIR APPLICABILITY TO THESE PROBLEMS. RESEARCH IN NON-LINEAR AND DYNAMIC PROGRAMMING WILL BE CONDUCTED WITH APPLICATIONS TO PROBLEMS IN OPERATIONS RESEARCH, SYSTEMS ANALYSIS, ALLOCATION OF RESOURCES AND MANAGEMENT DECISION THEORY. RESEARCH WILL CONTINUE ON GENERATING SEMI-ANALYTICAL AND LITERAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS. THE MATHEMATICS OF GENERAL RELATIVITY AND OF SETS OF NON-LINEAR PARTIAL DIFFERENTIAL EQUATIONS IS BEING STUDIED FROM THE STANDPOINT OF HIGH-SPEED NON-NUMERICAL MACHINE MANIPULATION OF THE ALGEBRA OF EXTERIOR DIFFERENTIAL FORMS.

RTOP NO. 129-04-20 TITLE: COMPUTER-ORIENTED MATHEMATICAL RESEARCH
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-3285
TECHNICAL SUMMARY

THE RESEARCH TO BE CONDUCTED UNDER THIS RTOP WILL BE DIRECTED

TOWARDS THE APPLICATION OF COMPUTERS TO AEROSPACE PROBLEMS. NEW OR IMPROVED METHODS WILL BE SOUGHT FOR DESCRIBING PROBLEM SITUATIONS IN MATHEMATICAL OR LOGICAL FORM AND FOR SOLVING THE RESULTING FORMULATIONS WITH THE AID OF A DIGITAL COMPUTER. ACTIVITIES WILL INVOLVE IDENTIFICATION AND STUDY OF AREAS OF MATHEMATICS AND COMPUTER SCIENCE HAVING POTENTIAL APPLICATION, DEVELOPMENT OF METHODS AND ASSOCIATED THEORY, COMPUTER EXPERIMENTATION, AND THE REPORTING OF RESULTS. MATHEMATICAL DISCIPLINES WILL INCLUDE NUMERICAL ANALYSIS, APPROXIMATION THEORY, MATRIX THEORY, DIFFERENTIAL EQUATIONS, OPTIMAL CONTROL THEORY AND STATISTICS. RELATED DISCIPLINES WILL INCLUDE INFORMATION, COMMUNICATION, AND DECISION THEORY AS WELL AS MAN-MACHINE COMMUNICATIONS. THIS WORK WILL PROVIDE A FOCAL POINT FOR THE DEVELOPMENT OF COMPUTER ORIENTED MATHEMATICS RELATED TO BROAD AREAS OF RESEARCH OF INTEREST AT THE LANGLEY RESEARCH CENTER. IT WILL BE COORDINATED WITH RELATED EFFORTS AT OTHER INSTALLATIONS AND THE RESULTS WILL BE AVAILABLE TO ORGANIZATIONS HAVING SIMILAR INTERESTS THROUGHOUT THE COUNTRY.

RTOP NO. 129-04-21 TITLE: INFORMATION SCIENCES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-1111
TECHNICAL SUMMARY

RESEARCH WILL BE CONDUCTED BOTH AT AMES AND UNDER COLLABORATIVE GRANT PROGRAMS, TO ADDRESS BASIC QUESTIONS IN THE AREAS OF HUMAN INFORMATION PROCESSING AND DECISION MAKING. MATHEMATICAL AND COMPUTER MODELS WILL BE DEVELOPED FOR COMPARISON WITH HUMAN SIGNAL DETECTION, CATEGORY FORMATION, PATTERN RECOGNITION, AND DECISION MAKING PERFORMANCE. THESE MODELS WILL BE REFINED TO SUIT PARTICULAR PERFORMANCE SITUATIONS. TECHNIQUES WILL ALSO BE DEVELOPED TO AID IN THE SELECTION, SCHEDULING, AND RESCHEDULING OF FLIGHT EXPERIMENTS. PARTICULAR ATTENTION WILL BE DIRECTED TOWARDS DETERMINING PRIORITIES ON A CARDINAL SCALE USING HUMAN OPINION DATA.

RTOP NO. 129-04-21 TITLE: INFORMATION SCIENCES
ORGANIZATION: NASA HEADQUARTERS
MONITOR: ROSENFELD, S. A. TEL. 202-962-0568
TECHNICAL SUMMARY

THE OBJECTIVE OF RESEARCH IN THE INFORMATION SCIENCES IS TO ENCOURAGE ADVANCES IN THOSE DISCIPLINES RELATED TO THE TRANSMISSION, ANALYSIS, STORAGE AND RETRIEVAL OF INFORMATION AS WELL AS WITH THOSE DISCIPLINES DIRECTED TOWARD THE USE OF THIS INFORMATION IN THE PROCESSES OF PLANNING, DECISION MAKING AND CONTROL. SPECIFIC RESEARCH AREAS INCLUDE: THE MATHEMATICAL THEORY OF INFORMATION PROCESSING; INFORMATION CLASSIFICATION AND RETRIEVAL; PROGRAMMING LANGUAGE AND LINGUISTICS RESEARCH; DECISION THEORY AND GAME THEORY; AND INTERACTIVE SYSTEMS AND INFORMATION DISPLAY. THIS NEW PROGRAM IS VITALLY IMPORTANT TO THE SUCCESSFUL COMPLETION OF FUTURE NASA MISSIONS. ALREADY WE ARE BEING SWAMPED WITH DATA FROM BOTH EARTH-BASED AND SPACE EXPERIMENTS PLANNED FOR THE NOT-SO-DISTANT FUTURE MAKE TODAY'S PROBLEMS SEEM TRIVIAL BY COMPARISON. FOR

EXAMPLE, THE INFORMATION RATE FROM JUST ONE PROPOSED PROGRAM, THE EARTH RESOURCES SATELLITE, PROMISES TO YIELD THE EQUIVALENT OF OVER 1,000,000 AVERAGE SIZED BOOKS PER DAY (OR 10 TO THE 14TH POWER BITS PER DAY.) THUS RESEARCH IN THE INFORMATION SCIENCES HAS A UNIQUE ASPECT OR URGENCY AND POTENTIAL PRODUCTIVITY.

RTOP NO. 129-04-22 TITLE: ASTRODYNAMICS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THIS RTOP, DESCRIBING BASIC RESEARCH IN ASTRODYNAMICS, HAS THE OBJECTIVE TO CONDUCT RESEARCH IN THE DEVELOPMENT OF ADVANCED TECHNIQUES FOR OBTAINING LITERAL EXPRESSIONS FOR THE SOLUTION OF THE NON-LINEAR DIFFERENTIAL EQUATIONS ARISING IN THE HAMILTONIAN FORMULATION OF THE MOTION OF ARTIFICIAL OR NATURAL SATELLITES OF THE EARTH OR ANOTHER PLANET. THE PROPOSED APPROACH WILL MAKE USE OF LIE SERIES IN CONJUNCTION WITH SUITABLE INTERMEDIATE TRAJECTORIES. THE ANTICIPATED RESULTS WILL BE VALUABLE FOR USE IN EMPLOYING SPACECRAFT-BASED MEASUREMENTS OF SATELLITES IN GUIDANCE TECHNIQUES FOR FUTURE MISSIONS.

RTOP NO. 130-06-07 TITLE: MISSION ANALYSIS AND SYSTEM DEFINITION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. E. TEL. 703-827-3585
TECHNICAL SUMMARY

STUDIES WILL BE DIRECTED TOWARD ANALYSES OF CONSUMMABLE BOOSTERS FOR SINGLE STAGE TO EARTH ORBIT OPERATION. THE INITIAL OBJECTIVE OF THESE ANALYSES WILL BE TO DEFINE MATERIAL PROPERTIES FOR CANDIDATE PROPELLANTS AND OXIDIZERS WHICH NORMALLY EXIST (STP) IN EITHER LIQUID OR GASEOUS FORM. SUCH INFORMATION WILL PROVIDE THE BASIS FROM WHICH THE BEST PROPELLANT/OXIDIZER MAY BE SELECTED FOR CONSUMMABLE BOOSTER APPLICATIONS. MORE DETAILED ANALYSES WILL THEN BE PERFORMED TO DEFINE THE SENSITIVITY OF THE SOLID ELEMENT OF THE CONSUMMABLE BOOSTER TO SUCH LAUNCH FACTORS AS SHOCK AND ACOUSTIC LOADINGS AS WELL AS THE ASSOCIATED MELTING SYSTEM REQUIREMENTS. THE FOCAL POINT OF THESE INITIAL EFFORTS WILL BE A PROOF OF CONCEPT DEMONSTRATION OF A CONSUMMABLE BOOSTER. IN CONJUNCTION WITH THESE ANALYSES, MISSIONS STUDIES WILL BE PERFORMED TO DEFINE THE PAYLOAD REQUIREMENTS OF THE CONSUMMABLE BOOSTER AND ITS INTEGRATION INTO A TOTAL SPACE TRANSPORTATION SYSTEM WHICH INCLUDES THE SPACE SHUTTLE AND ORBIT-TO-ORBIT SHUTTLE. THE LONG-TERM OBJECTIVE WILL BE TO MATE ENGINEERING HARDWARE DEVELOPMENT WITH FUTURE MISSION REQUIREMENTS TO PROVIDE THE TECHNOLOGY BASE FOR THE DEVELOPMENT OF THE CONSUMMABLE BOOSTER AS A VIABLE CANDIDATE FOR A NEW LAUNCH SYSTEM. STUDIES WILL BE PRIMARILY IN-HOUSE SUPPLEMENTED BY CONTRACTS IN SPECIALIZED AREAS AS REQUIRED.

RTOP NO. 130-06-08 TITLE: FLIGHT PATH DESIGN PROGRAM AND
INTERACTIVE GRAPHICS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

NUMEROUS COMPUTER PROGRAMS HAVE BEEN WRITTEN OVER THE PAST FEW YEARS TO SOLVE OR PROVIDE INFORMATION ON DIFFERENT FACETS OF THE OVERALL FLIGHT PATH DESIGN PROBLEM FOR A PLANETARY MISSION. HOWEVER, INPUT AND OUTPUT USUALLY EXCEED THAT ACTUALLY REQUIRED, COORDINATE SYSTEMS ARE FREQUENTLY INCONSISTENT FROM ONE PROGRAM TO THE NEXT, NEWER INFORMATION BECOMES AVAILABLE, ETC. WITH THE ARRIVAL OF THE "THIRD-GENERATION" COMPUTER SYSTEMS (SUCH AS THE UNIVAC 1108 OR IBM 360 AND ASSOCIATED PERIPHERALS) WITH THEIR INCREASED CAPABILITIES, THE NEED AND OPPORTUNITY EXIST TO FORM A COMPREHENSIVE FLIGHT PATH DESIGN PROGRAM (FPDP) BY PULLING TOGETHER THE BEST EXISTING CHECKED-OUT PROGRAMS AS "SUBPROGRAMS" WHICH COULD BE ACCESSED FROM A MASTER CONTROL MODULE (MCM), WHICH WOULD BE THE REAL "BRAINS" OF THE FPDP. THE MCM WOULD CONTAIN THE NECESSARY LOGIC TO ENABLE THE MISSION ANALYST (MA) TO UTILIZE THE VARIOUS SUBPROGRAMS, WHILE STILL MAINTAINING THE SIMPLEST FLOW OF KEY PARAMETERS ACROSS THE DIFFERENT INTERFACES. THE MCM WOULD ALSO "KNOW" WHAT INFORMATION TO REQUEST FROM THE MA AT EACH STEP DURING THE INTERACTIVE DESIGN PROCESS. IT IS ENVISIONED THAT THE MA WOULD SIT AT AN INTERACTIVE COMPUTER TERMINAL, WOULD CALL FOR THE FPDP, AND WOULD THEN PROCEED THROUGH AN ORDERLY "DIALOGUE" WITH THE COMPUTER WITH THE GOAL OF ACHIEVING AN APPROXIMATE DESIGN FOR THE FLIGHT PATH SPACE. BY "DIALOGUE" IS MEANT THAT THE MA WOULD SUPPLY INFORMATION TO THE MCM VIA KEYBOARD INPUT OR LIGHT PEN, WHILE THE COMPUTER WOULD RESPOND BY WORK MESSAGES OR GRAPHICAL RESULTS ON A DISPLAY SCREEN AT THE TERMINAL LOCATION. THE EXISTENCE OF A POWERFUL HUMAN/MACHINE COMBINATION TOOL SUCH AS THE FPDP WOULD PERMIT RAPID ASSESSMENT OF A VARIETY OF CANDIDATE FUTURE PLANETARY AND RELATED (COMETS, ASTEROIDS, ETC.) MISSIONS. THE MCM AND ASSOCIATED ALGORITHMS WOULD BE BASED UPON MANY YEARS OF EXPERIENCE IN THE AREA OF PLANETARY MISSION DESIGN, AND THE INCREASED USAGE OF MODERN GRAPHICS SYSTEMS WOULD ATTRACT A WIDE VARIETY OF USER LEVELS FROM ANALYST THROUGH MANAGER.

RTOP NO. 130-06-15 TITLE: SPACE PROGRAM PLANNING ANALYSIS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: DEERWESTER, J. M. TEL. 415-961-1111

TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS TO ANALYZE, DEVELOP AND TEST LONG-RANGE PLANNING METHODOLOGIES. THE METHODOLOGIES WILL PROVIDE FOR: THE CONSIDERATION OF ALTERNATIVE GOALS AND ALTERNATIVE PROGRAMMATIC COURSES OF ACTION; ASSESSMENT OF THE RISKS AND UNCERTAINTIES ASSOCIATED WITH THE OUTCOMES OF SUCH COURSES OF ACTION AND AN EVALUATION OF THE CONTRIBUTIONS THAT THE OUTCOMES MAY YIELD IN APPROACHING THE GOALS; ASSESSMENT OF THE ECONOMIC AND RESOURCE IMPLICATIONS OF PROGRAM ALTERNATIVES; DESCRIPTIONS OF THE ASSOCIATED TECHNICAL REQUIREMENTS AND CAPABILITIES; AND THE EXERCISE OF VARIOUS DECISION-MAKING PROCESSES ASSUMED FOR THE PURPOSE OF ANALYSIS.

RTOP NO. 130-06-16 TITLE: TECHNICAL REQUIREMENTS AND CAPABILITIES
ANALYSIS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: SWENSON, B. L. TEL. 415-961-1111

TECHNICAL SUMMARY

ELEMENTS OF ATTRACTIVE POSSIBLE FUTURE MISSIONS AND SPACECRAFT AND LAUNCH VEHICLE SYSTEMS ARE ANALYZED WITH A VIEW TOWARD DEFINING SYSTEMS REQUIREMENTS. THESE SYSTEMS REQUIREMENTS SERVE TO AID IN SELECTING DIRECTIONS FOR OART TECHNOLOGY DEVELOPMENT ACTIVITIES. THIS WORK IS CONDUCTED IN CONCERT WITH OVERALL STUDIES OF ADVANCED MISSIONS UNDER THE ADVANCED STUDY (CODE 789) PROGRAM. TYPICAL SUBJECTS STUDIED INCLUDE SPACE TRAJECTORIES, SPACE MISSION OPERATIONS, SENSOR SYSTEM REQUIREMENTS, AND ADVANCED PROPULSION SYSTEMS AND THEIR INTERACTION WITH THE PAYLOAD.

RTOP NO. 130-06-17 TITLE: AERONAUTICAL PROGRAM ANALYSIS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: DRAKE, H. M. TEL. 415-961-1111

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO CONDUCT TRANSPORTATION STUDIES, WITH EMPHASIS ON AIRCRAFT AND AIRCRAFT-RELATED SYSTEMS, IN ORDER TO PROVIDE INFORMATION RELEVANT TO: (A) THE PLANNING OF FUTURE AERONAUTICAL TRANSPORTATION SYSTEMS (B) THE PLANNING OF FUTURE AERONAUTICAL RESEARCH AND DEVELOPMENT PROGRAMS. THESE STUDIES WILL INVOLVE THE DEVELOPMENT AND APPLICATION OF ANALYTICAL TECHNIQUES TO INVESTIGATE THE IMPACTS OF CHANGES IN DEMAND, ALTERNATE TRANSPORTATION MODES, TECHNOLOGY ADVANCES, CHANGES IN OPERATING PROCEDURES, ETC. ON THE EVOLUTION OF TRANSPORTATION SYSTEMS; AND TO ESTIMATE THE COSTS AND BENEFITS OF ALTERNATIVE AERONAUTICAL RESEARCH AND DEVELOPMENT PROGRAMS.

RTOP NO. 130-06-18 TITLE: PROGRAM ECONOMIC ANALYSIS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: HORNBY, H. TEL. 415-961-1111

TECHNICAL SUMMARY

ECONOMIC AS WELL AS TECHNOLOGICAL PROBLEMS ARE KEY FACTORS IN DETERMINING THE FUTURE DIRECTION OF THE SPACE PROGRAM. EFFECTIVE, VIABLE PROGRAM ANALYSES THEREFORE MUST INCLUDE ECONOMIC MEASURES AND FORECASTS. ANALYSES WOULD INVESTIGATE PROGRAM ECONOMICS IN TERMS OF COSTS AND BENEFITS, USING APPROPRIATE ESTIMATION TECHNIQUES AND MODELS SUCH AS AN EXISTING SELECTION ALGORITHM. SENSITIVITIES TO VARIATIONS IN TECHNOLOGY AND RESOURCE AVAILABILITY, BUDGET LIMITATIONS AND CONSTRAINTS, AND MANAGEMENT AND OPERATIONAL PHILOSOPHY WOULD BE INCLUDED. A BUDGET SMOOTHING MODEL IS CURRENTLY PROVIDING SIGNIFICANT SENSITIVITY DATA. AN EXTENSIVE DATA BANK IS ALSO CURRENTLY IN USE. THE RESULTS THEN ARE AN ASSESSMENT OF THE IMPACT OF ECONOMIC CONSIDERATIONS UPON PROGRAM ANALYSIS AND TECHNOLOGY PLANNING.

RTOP NO. 130-06-20 TITLE: PLANETARY IMAGING RADAR STUDY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

SPACECRAFT IMAGING RADAR SYSTEMS WILL BE STUDIED THAT ARE PARTICULARLY SUITABLE FOR EXPLORING THE SURFACE OF VENUS FROM AN ORBITING TRAJECTORY. PROBLEMS PECULIAR TO THESE SYSTEMS INCLUDE THE RADAR IMAGING GEOMETRY, EFFECTS OF PLATFORM STABILITY ON SYNTHETIC APERTURES, EFFECTS OF ATMOSPHERIC VARIATIONS ON THE IMAGERY, TECHNIQUES FOR REMOTELY MODIFYING THE RESOLUTION MODE OF OPERATION, AND EXTENDED OBSERVATIONAL (RELIABILITY) ASPECTS. THESE PROBLEMS AND OTHERS THAT ARE RELATED TO THE REQUIRED FUTURE DEVELOPMENT OF THE EXPERIMENT WILL BE STUDIED. TECHNIQUES FOR OPERATING IN LOW, MEDIUM AND HIGH RESOLUTION MODES AND HANDLING THE DATA ARE PERTINENT AND WILL BE A SIGNIFICANT PART OF THE STUDY. COST INFORMATION ON THE SYSTEM IMPLEMENTATION WILL BE PROVIDED.

RTOP NO. 130-06-21 TITLE: OART MISSION ANALYSIS - MANAGEMENT SUPPORT
ORGANIZATION: NASA HEADQUARTERS
MONITOR: WISNIEWSKI, R. J. TEL. 202-962-3363
TECHNICAL SUMMARY

THIS PROGRAM WILL CONSIST OF CONTRACTED STUDIES AND SERVICES NECESSARY TO SUPPORT OART IN-HOUSE AND CONTRACTED MISSION AND SYSTEMS STUDIES. THE STUDIES WILL INCLUDE THE DEVELOPMENT OF VARIOUS ANALYTICAL TECHNIQUES TO ASSESS RISKS AND UNCERTAINTIES, EVALUATE THE CONTRIBUTIONS OF PROJECTS, DETERMINE IMPLICATIONS OF ALTERNATIVE PROGRAMS, DEVELOP AND TEST DECISION-MAKING PROCESSES USED IN MANAGEMENT ANALYSIS, AND PROVIDE FOR PUBLICATION, DOCUMENTATION AND VISUAL DISPLAYS OF NASA RESEARCH ACTIVITIES.

RTOP NO. 131-05-01 TITLE: AEROSPACE SAFETY DATA BANK
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: GOLDSTEIN, C. M. TEL. 216-433-4000
TECHNICAL SUMMARY

OBJECTIVE: TO ESTABLISH AN AEROSPACE SAFETY DATA BANK TO GATHER, ANALYZE AND DISSEMINATE TECHNICAL SAFETY-RELATED INFORMATION AVAILABLE TO ALL ELEMENTS OF NASA, ITS CONTRACTORS AND THE TECHNICAL COMMUNITY; TO ASSURE THAT INFORMATION ON THE LATEST STATE-OF-THE-ART REGARDING SAFETY IS AVAILABLE FOR USE IN PLANNING, DESIGN, FABRICATION, TESTING AND OPERATIONS OF AEROSPACE VEHICLES AND SYSTEMS AND ASSOCIATED FACILITIES. APPROACH: THE ASRDI WILL CALL ON ALL ELEMENTS OF NASA, ITS CONTRACTORS, AND OTHER ORGANIZATIONS TO PROVIDE BASIC, APPLIED AND OPERATIONAL DATA RELATED TO GROUND-BASED AND FLIGHT SAFETY EXPERIENCE FOR THE AEROSPACE SAFETY DATA BANK. INVESTIGATION WILL BE MADE OF SIMILAR ACTIVITIES IN GOVERNMENT AND INDUSTRY TO ESTABLISH THE EXTENT AND NATURE OF EXISTING COMPILATIONS OF ACCURATE DATA. LIAISON WILL BE ESTABLISHED WITH THESE ACTIVITIES

TO ASSURE ACCESS TO THE INFORMATION CONTAINED IN THESE SOURCES AS NEEDED, AND/OR SELECTED INFORMATION WILL BE IDENTIFIED AND INCORPORATED INTO THE ASRDI AEROSPACE SAFETY DATA BANK AS APPROPRIATE. A MANAGEMENT MECHANISM WILL BE ESTABLISHED TO PROVIDE FOR THE FLOW OF ALL SUCH INFORMATION INTO THE DATA BANK. THE INFORMATION WILL BE ANALYZED, VERIFIED, CORRELATED AND QUALIFIED AS REQUIRED. THIS INFORMATION WILL BE MADE AVAILABLE TO ALL ELEMENTS OF NASA, ITS CONTRACTORS, OTHER GOVERNMENT AGENCIES, AND THE TECHNICAL COMMUNITY. IMPROVED METHODS OF STORING, SEARCHING AND RETRIEVING INFORMATION WILL HAVE A WIDESPREAD APPLICABILITY IN THE GENERAL AREA OF INFORMATION PROCESSING.

RTOP NO. 131-05-02 TITLE: AERONAUTICAL SAFETY RESEARCH
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: WEISS, S. TEL. 216-433-4000
TECHNICAL SUMMARY

ASRDI WILL MAINTAIN AN OVERVIEW OF AERONAUTICAL SAFETY RESEARCH PROGRAMS. IT WILL COMPARE CURRENT PROGRAMS WITH AIRCRAFT SAFETY INFORMATION REQUIREMENTS TO ESTABLISH THE NEED FOR ADDITIONAL RESEARCH. IN ASSOCIATION WITH THE AERONAUTICS DIVISION OF OART, NASA CENTERS AND THE AIRCRAFT COMMUNITY, CONDUCT RESEARCH PROGRAMS AS REQUIRED TO SEEK PRACTICAL SOLUTIONS TO SAFETY PROBLEMS ASSOCIATED WITH AIRCRAFT AND THEIR GROUND BASED ACTIVITIES. THESE RESEARCH PROGRAMS WILL BE DESIGNED TO PROVIDE NEW TECHNIQUES FOR HANDLING PRESENT SAFETY PROBLEMS AND THOSE ANTICIPATED BY THE INTRODUCTION OF NEW AIRCRAFT TYPES, NOVEL AIRCRAFT COMPONENTS AND UNCONVENTIONAL FUELS.

RTOP NO. 131-05-03 TITLE: SPACE SAFETY RESEARCH
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: HACKER, P. T. TEL. 216-433-4000
TECHNICAL SUMMARY

IN ORDER TO MEET THE HIGH SAFETY STANDARDS THAT NASA WISHES TO ESTABLISH IN ITS SPACE ACTIVITIES BOTH IN FLIGHT AND IN TEST FACILITIES, ASRDI WILL PERFORM THE FOLLOWING FUNCTIONS IN SUPPORT OF THE TOTAL NASA SAFETY EFFORT IN ASSOCIATION WITH OTHER NASA GROUPS:

1. DEFINE THE REQUIREMENTS OF SPACE VEHICLE AND FACILITY SYSTEMS THAT MINIMIZE RISK, SINCE SPACE VEHICLES REPRESENT COMPACT COMBINATIONS OF VITAL SYSTEMS IN WHICH A FAILURE IN ONE HAS A HIGH LIKELIHOOD OF DAMAGING THE OTHER. THE NEED FOR LOW SYSTEM FAILURE PROBABILITY AND HIGH RECOVERY RATE, SHOULD FAILURE OCCUR, IS MORE STRINGENT THAN PRESENT ENGINEERING EXPERIENCE OFTEN PROVIDES. TO IMPROVE THIS SITUATION, ASRDI WILL CONDUCT, OR HAVE CONDUCTED FOR IT, ENGINEERING EVALUATION OF EXISTING SAFETY RELATED INFORMATION, DRAWN FROM THE LITERATURE AND CURRENT PROGRAMS, WHICH FOCUS ON SPACE VEHICLE SAFETY TECHNOLOGY. GAPS IN INFORMATION WILL BE FILLED BY RESEARCH PROGRAMS CONDUCTED IN ASSOCIATION WITH OTHER SEGMENTS OF NASA. EVERY EFFORT WILL BE MADE TO PROVIDE THE INFORMATION EARLY ENOUGH FOR INCORPORATION IN THE EARLY PLANNING PHASES OF SPACE VEHICLE DESIGN AND OPERATION.
2. IMPROVE THE SAFETY OF SUPPORT

FUNCTIONS IN NASA AND CONTRACTOR OPERATIONS WHICH RAISE INDUSTRIAL AND PUBLIC SAFETY PROBLEMS. RESEARCH IS OFTEN REQUIRED TO PROVIDE A BASIS FOR IMPROVED SAFETY CODES, PRACTICES AND AUXILIARY SAFETY EQUIPMENT. ASRDI WILL CONTRIBUTE RESEARCH AND OTHER TECHNICAL SUPPORT TO IMPROVE THE RULES AND TECHNIQUES BY WHICH SAFETY IS ACHIEVED IN THE AEROSPACE INDUSTRY. BECAUSE ASRDI RESEARCH IS OFTEN AIMED AT FILLING INFORMATION VOIDS IN A WIDE RANGE OF SAFETY FIELDS, THE CONNECTING THEME FOR ALL OF ASRDI RESEARCH CAN ONLY BE ITS RELEVANCE TO SAFETY.

RTOP NO. 160-20-51 TITLE: SPACECRAFT SYSTEMS AND TECHNOLOGY

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: FLAHERTY, J. B. TEL. 301-982-6876

TECHNICAL SUMMARY

STUDIES COVERING BOTH COMPLETE SPACECRAFT AND APPLICABLE PORTIONS OF SPACECRAFT WILL BE UNDERTAKEN IN SUPPORT OF FUTURE SYSTEMS IN THE GENERAL TECHNOLOGICAL AREA OF EARTH OBSERVATIONS PROGRAMS. IN ADDITION TO GENERAL SPACECRAFT TECHNOLOGICAL STUDIES COVERING THE SYNTHESIS OF THE SPACEBORNE PORTION OF A PLANNED SYSTEM, GENERAL STUDIES COVERING SUCH AREAS AS FREQUENCY SEARCHES WILL BE UNDERTAKEN. SPECIFIC SPACECRAFT SUBSYSTEMS ELEMENTS, SUCH AS ANTENNAS, COMMAND AND TELEMETRY HARDWARE, SPACECRAFT POWER, AND CONTROLS EQUIPMENTS WILL BE INVESTIGATED AS PART OF THIS EFFORT FOR THE PURPOSE OF SUPPLYING THE REQUISITE ADVANCED TECHNOLOGY TO MESH WITH SPACECRAFT WHICH ARE TO BE SYNTHESIZED IN CARRYING OUT THE MORE GENERAL OBJECTIVES OF THIS EFFORT.

RTOP NO. 160-20-52 TITLE: DATA MANAGEMENT AND STORAGE

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: MAXWELL, M. S. TEL. 301-982-4036

TECHNICAL SUMMARY

THE NEXT GENERATION OF EARTH ORIENTED SPACECRAFT, WITH PAYLOADS OF HIGH RESOLUTION SENSORS AND LONG LIFE EXPECTANCIES, WILL GENERATE A GREATER AMOUNT OF EXPERIMENT AND HOUSEKEEPING DATA THAN CURRENT OPERATING SYSTEMS. TECHNIQUES AND EQUIPMENT MUST BE DEVELOPED TO ACQUIRE AND THEN REDUCE THE AMOUNT OF SPACECRAFT DATA THAT MUST BE STORED IN THE VEHICLE. THIS WILL BE DONE USING REDUNDANCY REDUCTION TECHNIQUES AND ON-BOARD DATA PROCESSING SO THAT THE QUANTITY OF DATA TO BE STORED WILL BE REDUCED TO A SUFFICIENTLY SMALL NUMBER OF BITS THAT THEY MAY BE STORED IN A SMALL, LIGHT, RELIABLE MEMORY ON THE SPACECRAFT. ESSENTIAL TO THIS GOAL IS OPTIMIZATION OF THE STORAGE MEDIA AND ON-BOARD PROCESSING SYSTEMS TO PROVIDE AN EFFICIENT MATCH WITH THE DATA VOLUME TO BE PROCESSED, STORED AND TRANSMITTED AND THE DELINEATION AND DESIGN OF THE ASSOCIATED GROUND SUPPORT EQUIPMENT. CLOSE LIAISON WILL BE MAINTAINED WITH THE RTOP 160-75-52 PROGRAM IN ORDER TO MAXIMIZE MUTUAL BENEFITS.

RTOP NO. 160-20-53 TITLE: VISIBLE AND IR SENSOR TECHNOLOGY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: OSTROW, H. TEL. 301-982-4107
TECHNICAL SUMMARY

IMAGING SYSTEMS WITH ADVANCED PERFORMANCE CAPABILITY ARE REQUIRED FOR FUTURE EARTH OBSERVATION MISSIONS. THE STATE-OF-THE-ART ADVANCES OCCURRING IN SENSOR TECHNOLOGY MAKE IT POSSIBLE TO UNDERTAKE DEVELOPMENT OF THE NEXT GENERATION OF IMAGING INSTRUMENTS OVERCOMING SOME OF THE LIMITATIONS OF EXISTING SYSTEMS, SUCH AS THE RBV AND MSS. SYSTEMS WHICH PROVIDE INCREASED SPATIAL AND SPECTRAL RESOLUTION ALONG WITH INHERENT REGISTRATION BETWEEN SPECTRAL CHANNELS ARE REQUIRED. MANY DESIRED CHARACTERISTICS CAN BE ACHIEVED ONLY BY THE DEVELOPMENT OF SUITABLE SENSORS. FOR EXAMPLE, LARGE LINE ARRAYS OFFER MANY ADVANTAGES. SOLID STATE ARRAY TECHNOLOGY HAS REACHED THE POINT WHERE LINEAR ARRAYS ON THE ORDER OF 10,000 ELEMENTS CAN BE FABRICATED. WITH ARRAYS OF THIS LENGTH, HIGH SPATIAL RESOLUTION CAN BE ACHIEVED WITHOUT USE OF COMPLICATED MECHANICAL SCANNING TECHNIQUES. SPECTRAL RESPONSE AND SENSITIVITY CAN BE IMPROVED BY THE PROPER PHOTOSENSITIVE DETECTOR MATERIAL. REGISTERED MULTISPECTRAL DATA CAN BE OBTAINED USING MULTIPLE ARRAYS AND A COMMON OPTICAL SYSTEM. LINE SCAN SENSORS USING ELECTRON BEAM READOUT TECHNIQUES CAN ALSO BE PRODUCED. ELECTRON BEAM READOUT SENSORS ELIMINATE THE NECESSITY FOR MAKING ELECTRICAL CONTACT WITH EACH DETECTOR ELEMENT, AND THIS OFFERS SIMPLIFICATION IN FABRICATION. HOWEVER, PHOTO-SURFACES WILL HAVE TO BE IMPROVED TO EXTEND THE PERFORMANCE FURTHER INTO THE NEAR IR REGION. OTHER ADVANCED IMAGE SENSOR TECHNIQUES APPEAR APPLICABLE. ONE TECHNIQUE USES AN OPTICAL FILTER WHICH SEPARATELY ENCODES THE SPECTRAL INFORMATION INTO DISCRETE AND SEPARABLE CHANNELS IN THE FREQUENCY DOMAIN. THIS TECHNIQUE IS NOW BEING USED IN SOME GROUND BASED APPLICATIONS AND PROVIDE INHERENTLY PERFECT REGISTRATION. THE EXTENSION OF THE TECHNIQUE TO EARTH OBSERVATION SYSTEMS WILL BE PURSUED.

RTOP NO. 160-20-54 TITLE: MICROWAVE AND MILLIMETER WAVE RADIOMETER
SYSTEMS DEVELOPMENT

ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-3285
TECHNICAL SUMMARY

THE MAJOR OBJECTIVES OF THIS WORK ARE TO INVESTIGATE THE APPLICABILITY OF PASSIVE RADIOMETRY FOR REMOTE SENSING APPLICATIONS IN METEOROLOGY, AERONOMY, OCEANOGRAPHY, AND EARTH RESOURCES EXPERIMENTS AND TO ADVANCE THE STATE-OF-THE-ART IN MICROWAVE AND MILLIMETER WAVE RADIOMETERS FOR SPECIFIC FLIGHT APPLICATIONS. THE SCOPE OF THE WORK INCLUDES RESEARCH AND DEVELOPMENT ON LOW NOISE, HIGH BEAM EFFICIENCY PHASED ARRAY ANTENNAS, THE DEVELOPMENT OF SOLID STATE MICROWAVE AND MILLIMETER WAVE OSCILLATORS AND AMPLIFIERS, THE DESIGN OF THICK FILM MICROWAVE INTEGRATED CIRCUITS AND THE EXPERIMENTAL MEASUREMENT OF THE MICROWAVE EMISSION OF THE ATMOSPHERE AND OCEAN SURFACE AT MICROWAVE AND MILLIMETER WAVELENGTHS.

RTOP NO. 160-20-55 TITLE: COOLING SYSTEMS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: CALLENS, R. A. TEL. 301-982-4205
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP A CENTRAL SPACECRAFT SYSTEM FOR COOLING TO CRYOGENIC TEMPERATURES SPACECRAFT COMPONENTS THAT REQUIRE LOW TEMPERATURES IN ORDER TO OPERATE OR TO INCREASE THEIR SENSITIVITY AND PERFORMANCE. THE APPROACH INCLUDES THE DESIGN AND DEVELOPMENT OF: (1) AN ACTIVE VUILLEUMIER CRYOGENIC REFRIGERATOR SUITABLE FOR LONG TERM SPACE APPLICATION, (2) CRYOGENIC TEMPERATURE HEAT PIPES TO DISTRIBUTE CRYOGENIC COOLING THROUGHOUT SPACECRAFT AND TO INTERFACE WITH ACTIVE CRYOGENIC COOLERS, AND (3) HIGHER TEMPERATURE HEAT PIPES FOR SPACECRAFT THERMAL CONTROL OF HIGH-WATTAGE, CONCENTRATED HEAT SOURCES. ACTIVE COOLERS, OTHER THAN THE VUILLEUMIER CRYOGENIC REFRIGERATOR, WILL BE INVESTIGATED FOR SPACECRAFT APPLICATION TO COOL TO LOW TEMPERATURES THERMAL LOADS FROM ONE TO TEN WATTS.

RTOP NO. 160-20-56 TITLE: AIR POLLUTION SENSING
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. TEL. 703-827-3825
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP TECHNIQUES AND SYSTEMS FOR THE REMOTE DETECTION AND MEASUREMENT OF ATMOSPHERIC POLLUTANTS FROM AIRCRAFT AND ORBITAL SPACECRAFT. A NONDISPERSIVE RADIOMETRIC SENSOR FOR USE IN AIRCRAFT IS BEING DEVELOPED TO VERIFY A PROMISING SENSING TECHNIQUE FOR CARBON MONOXIDE, AND WILL BE EXPANDED FOR FLIGHT MEASUREMENTS OF OTHER GASEOUS ATMOSPHERIC POLLUTANTS. GROUND MEASUREMENTS OF THE SPECTRAL CHARACTERISTICS OF HIGHLY POLLUTED URBAN ATMOSPHERES ARE BEING OBTAINED FROM A MOBILE VAN CONTAINING AN INFRARED MONOCHROMETER WHICH VIEWS THE SUN'S SPECTRUM THROUGH A LONG ATMOSPHERIC PATH. THE DEVELOPMENT OF INSTRUMENTATION AND TECHNOLOGY ON THIS RTOP WILL PROVIDE THE BASIC DESIGN INFORMATION FOR SATELLITE SYSTEMS OR MONITOR AIR POLLUTION LEVELS AND PROVIDE DATA ON TEMPORAL AND SPATIAL DISTRIBUTIONS OF POLLUTANTS WHICH ARE NEEDED TO ALLOW DEVELOPMENT OF ANALYTICAL MODELS TO PREDICT POLLUTION LEVELS AND ESTABLISH POLLUTION CONTROLS.

RTOP NO. 160-20-57 TITLE: CHEMICAL AND SPECTROSCOPIC INVESTIGATION
OF AIR POLLUTANTS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

TO CONTRIBUTE TO THE ELIMINATION OF AIR POLLUTION BY INVESTIGATING THE CHEMICAL PROCESSES OCCURRING IN AIR POLLUTION USING THE TECHNIQUES OF PHOTOCHEMISTRY AND SPECTROSCOPY. CHEMICAL STUDIES WILL FOCUS PRIMARILY ON THE PHOTOCHEMICAL PRODUCTION OF AIR POLLUTANTS. INFORMATION FROM THESE STUDIES IS NECESSARY IN ORDER TO FORMULATE REALISTIC MODELS OF THE CHEMICAL INTERACTIONS OCCURRING IN THE POLLUTION PROCESS AND TO PROVIDE A MEANINGFUL BASIS FOR THE ESTABLISHMENT OF ACCEPTABLE POLLUTANT CONCENTRATIONS IN THE

ATMOSPHERE AND IN EMISSION SOURCES. THE SPECTROSCOPIC STUDIES WILL COMPLEMENT THE PHOTOCHEMICAL STUDIES BY PROVIDING INFORMATION ON THE DETECTION, IDENTIFICATION, AND MEASUREMENT OF ABUNDANCE AND VARIATION OF POLLUTANT MOLECULES OR RADICALS IN THE ATMOSPHERE. THIS PART OF THE PROGRAM UTILIZES THE EXISTING FACILITIES FOR HIGH RESOLUTION UV, VISIBLE AND INFRARED SPECTROSCOPY AT THE JET PROPULSION LABORATORY. THIS RESEARCH CAN LEAD TO EFFECTIVE CONTROL OF POLLUTANTS BY UNDERSTANDING THEIR ORIGIN AND PRODUCTION.

RTOP NO. 160-20-58 TITLE: ADVANCED SENSOR FEASIBILITY STUDIES

ORGANIZATION: NASA HEADQUARTERS

MONITOR: LEHMANN, J.

TEL. 202-962-4563

TECHNICAL SUMMARY

REQUIREMENTS FOR EARTH OBSERVATION APPLICATIONS ARE PUSHING THE STATE OF THE ART IN SPACECRAFT REMOTE SENSORS. A WIDE RANGE OF THE ELECTROMAGNETIC SPECTRUM IS UNDER STUDY FOR NEW METHODS OF DETECTING AND MEASURING FACTORS RELATED TO THE EARTH'S SURFACE AND/OR ATMOSPHERE. THE PURPOSE OF THE EFFORT COVERED BY THIS RTOP IS TO INVESTIGATE THE APPLICATION OF NEW PRINCIPLES AND NEW DESIGN APPROACHES FOR REMOTE SENSING. THIS IS TO BE ACCOMPLISHED BY SUPPORT OF SELECTED RESEARCH TASKS PROPOSED BY INVESTIGATORS FROM UNIVERSITIES, SMALL ACADEMIC CENTERS, AND OTHER RESEARCH ORGANIZATIONS WHO ARE HIGHLY QUALIFIED IN THEIR RESPECTIVE FIELDS. THE INVESTIGATIONS WILL INCLUDE NEW IDEAS, TECHNIQUES, DETECTION SCHEMES, ETC. NOT YET VERIFIED BY PRACTICE, WHICH HAVE POTENTIAL APPLICATIONS FOR FUTURE REMOTE SENSOR CONCEPTS.

RTOP NO. 160-20-59 TITLE: HIGH SPEED INTERFEROMETER EXPERIMENT
DEVELOPMENT

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BURCHAM, D. P.

TEL. 213-354-3028

TECHNICAL SUMMARY

THE HIGH SPEED INTERFEROMETER IS A FOURIER SPECTROMETER DESIGNED SPECIFICALLY FOR REMOTE OPERATION IN A SATELLITE OR SPACECRAFT ENVIRONMENT. THE END OBJECTIVE OF THE PRESENT INSTRUMENT DEVELOPMENT PROGRAM IS TO USE THE SYSTEM IN AN EARTH ORBITING SATELLITE FOR SURVEYING, ON A GLOBAL SCALE, THE DISTRIBUTION OF ATMOSPHERIC TRACE CONSTITUENTS AND POLLUTANTS. THE PRESENT PHASE OF THE WORK IS CONCERNED WITH VERIFYING THE PERFORMANCE OF THE LABORATORY VERSION OF THE INSTRUMENT AND GAINING EXPERIENCE WITH ITS OPERATION AND DATA HANDLING. THE PROGRAM DURING THE CURRENT YEAR WILL YIELD USEFUL SCIENTIFIC DATA IN THE FORM OF HIGH RESOLUTION ATMOSPHERIC SPECTRA AND LEVELS OF MINIMUM DETECTABLE CONCENTRATIONS.

RTOP NO. 160-44-51 TITLE: DEVELOPMENT AND OPTIMIZATION OF REMOTE
SENSING TECHNIQUES FOR METEOROLOGICAL
APPLICATION

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: BANDEEN, W. R. TEL. 301-982-4416

TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP, IMPROVE, AND OPTIMIZE REMOTE SENSING TECHNIQUES FOR THE QUANTITATIVE MEASUREMENT OF METEOROLOGICAL PHENOMENA SUCH AS ATMOSPHERIC STRUCTURE, COMPOSITION, AND DYNAMICS; CLOUD COVER AND HEIGHT DISTRIBUTIONS; THE RADIATION BALANCE; AND SEA-SURFACE TEMPERATURE AND OTHER PARAMETERS RELATING TO THE AIR-EARTH SURFACE INTERFACE; AND TO ANALYZE AND INTERPRET DATA ACQUIRED FROM EXPERIMENTS FLOWN ON METEOROLOGICAL SATELLITES TO ASSESS THE VALIDITY OF THE DIFFERENT SENSING TECHNIQUES AND TO INCREASE OUR UNDERSTANDING OF THE EARTH-ATMOSPHERE SYSTEM. SPECIFIC FOCAL POINTS OF THIS RESEARCH ARE THE ESTABLISHMENT OF A BASIS FOR THE SPECIFICATION OF THE REMOTE SENSING PART OF THE GLOBAL METEOROLOGICAL OBSERVING SYSTEM OF THE 1970'S REQUIRED FOR LARGE-SCALE, LONG-TERM WEATHER FORECASTS (VIZ. THE GLOBAL ATMOSPHERIC RESEARCH PROGRAM - GARP), AND, SIMILARLY, THE ESTABLISHMENT OF A BASIS FOR THE SPECIFICATION OF A SYSTEM FOR CONTINUOUS OBSERVATION OF WEATHER FEATURES SO THAT THESE OBSERVATIONS CAN BE APPLIED TO SHORT-TERM WEATHER FORECASTS.

RTOP NO. 160-44-52 TITLE: APPLICATION OF METEOROLOGICAL SATELLITE
DATA TO GENERAL CIRCULATION MODELS

ORGANIZATION: GODDARD INSTITUTE FOR SPACE STUDIES

MONITOR: JASTROW, R. TEL. 212-866-3550

TECHNICAL SUMMARY

THE GODDARD INSTITUTE FOR SPACE STUDIES IS A NEW YORK OFFICE OF THE SPACE AND EARTH SCIENCES DIRECTORATE, GODDARD SPACE FLIGHT CENTER. ITS RESEARCH PROGRAMS INCLUDE: ASTROPHYSICS, PLANETARY PHYSICS, AND ATMOSPHERIC PHYSICS. THE ATMOSPHERIC PHYSICS PROGRAM INCLUDES STUDIES OF THE ATMOSPHERES OF MARS AND VENUS BASED ON SPACECRAFT DATA; BASIC CIRCULATION OF THE TERRESTRIAL ATMOSPHERE IN CONJUNCTION WITH METEOROLOGICAL SATELLITE DATA; AND CONDUCTING NUMERICAL MODELLING RESEARCH AND OBSERVING SYSTEM SIMULATION STUDIES FOR THE GLOBAL ATMOSPHERIC RESEARCH PROGRAM. (GARP) COMPUTER PROGRAMS ARE DEVELOPED AND ANALYSES ARE MADE TO PROVE THE PREDICTION CAPABILITY OF ATMOSPHERIC MODELS AND NUMERICAL MODELLING EXPERIMENTS.

ONE OF THE PRIMARY AIMS OF THE GARP GLOBAL EXPERIMENT IS THE IMPROVEMENT OF MODELS BY TESTING THEIR FORECASTS AGAINST OBSERVATIONS. A LONG-TERM CONTINUING PROGRAM OF MODELLING RESEARCH IS NEEDED FOR THE DEVELOPMENT OF IMPROVED ATMOSPHERIC MODELS.

RTOP NO. 160-44-53 TITLE: REMOTE SENSING TECHNIQUES FOR CLOUD
STRUCTURE, PRECIPITATION, AND SURFACE
CONDITIONS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: HOVIS, W. A. TEL. 301-982-6465

TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP AND TEST METHODS OF REMOTELY SENSING CLOUD PHYSICAL PARAMETERS, SUCH AS WATER CONTENT, PHASE, I.E. WATER OR ICE, PARTICLE SIZE AND SIZE DISTRIBUTION AND THE EFFECTS OF UNDERLYING SURFACE CHARACTER ON SUCH MEASUREMENTS. MEASUREMENTS ARE MADE WITH AIRCRAFT-BORNE SPECTROMETERS AND RADIOMETERS, RANGING FROM VISIBLE TO MICROWAVE REGIONS OF THE SPECTRUM, TO DETERMINE THE ABILITY OF SUCH DEVICES TO REMOTELY SENSE CLOUD TYPE AND CONDITION. IN-SITU MEASUREMENTS OF CLOUD PARAMETERS SUCH AS PARTICLE SIZE AND SIZE DISTRIBUTION ARE MADE BY FLYING THROUGH CLOUDS AND UTILIZING LASER NEPHELOMETERS AND AIRCRAFT SENSORS. OVERFLIGHTS OF THE SAME CLOUDS PROVIDE THE OPPORTUNITY TO ASSESS THE RELIABILITY OF REMOTE SENSING. RESULTS OBTAINED ARE USED TO GUIDE IN THE DEVELOPMENT OF SPACECRAFT SENSOR SYSTEMS TO PROVIDE INFORMATION ON CLOUD MOISTURE AND PHASE ON A GLOBAL SCALE.

RTOP NO. 160-44-54 TITLE: RADIATIVE TRANSFER MODELS RELATING TO
ATMOSPHERE AND SURFACE CHARACTERISTICS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: PRABHAKARA, C. TEL. 301-982-4409

TECHNICAL SUMMARY

THE OBJECTIVE IS TO DETERMINE THE RADIATIVE CHARACTERISTICS OF THE OPTICALLY ACTIVE GAS AND PARTICULATE CONSTITUENTS (CIRRUS, WATER CLOUDS, AND AEROSOLS) OF THE ATMOSPHERE AND THE EMISSIVITY AND REFLECTIVITY OF DIFFERENT TYPES OF SURFACES; AND TO OPTIMIZE THE NUMERICAL SOLUTION TO THE RADIATIVE TRANSFER EQUATION, INCLUDING MULTIPLE SCATTERING AND POLARIZATION. LABORATORY MEASUREMENTS, INVOLVING ABSORPTION TUBES, WILL BE MADE TO STUDY THE RADIATIVE PROPERTIES OF THE OPTICALLY ACTIVE GASES. THEORETICAL ANALYSES OF SPECTRAL LINE INTENSITIES, POSITIONS, AND SHAPES WILL BE MADE IN CONJUNCTION WITH THE EXPERIMENTAL MEASUREMENTS. AN INFRARED INTERFEROMETER SPECTROMETER (IRIS) WILL BE FLOWN ALOFT BY MEANS OF A HIGH ALTITUDE BALLOON AND INFRARED SPECTRAL WILL BE OBTAINED WITH A RESOLUTION OF 0.05 CM, IN THE SPECTRAL REGION 5-25 MICRON. THESE MEASUREMENTS WILL BE USED TO INVESTIGATE RADIATIVE PROPERTIES OF THE SURFACE OF THE EARTH AND OF OPTICALLY ACTIVE GASES AND PARTICULATES IN THE ATMOSPHERE. THESE STUDIES WILL PROVIDE THE PHYSICAL BASIS FOR REMOTELY SOUNDING THE ATMOSPHERE AND FOR SENSING CHARACTERISTICS OF THE SURFACE BOUNDARY SUCH AS LAND AND SEA SURFACE TEMPERATURES, SOIL MOISTURE, ETC.

RTOP NO. 160-44-55 TITLE: ANALYSIS OF THE ENERGY INTERACTIONS
BETWEEN ATMOSPHERIC LEVELS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: THEON, J. S. TEL. 301-982-5249

TECHNICAL SUMMARY

THE OBJECTIVE IS TO STUDY THE INTERACTIONS OF MECHANICAL, RADIATIONAL, AND CHEMICAL ENERGIES BETWEEN THE LOWER AND UPPER REGIONS OF THE ATMOSPHERE. THE AREAS OF STUDY INCLUDE: GRAVITY WAVES, TIDES, AND TURBULENCE ORIGINATING IN THE LOWER ATMOSPHERE; ABSORPTION AND RERADIATION OF SOLAR AND TERRESTRIAL ENERGY BY CONSTITUENTS IN THE STRATOSPHERE AND MESOSPHERE; PHOTOCHEMICAL AND CHEMICAL REACTIONS IN THE UPPER ATMOSPHERE; AND HORIZONTAL AND VERTICAL TRANSPORT PROCESSES. EXISTING SOUNDING ROCKET AND SATELLITE TECHNIQUES WILL BE EMPLOYED, AND NEW SOUNDING ROCKET AND SATELLITE TECHNIQUES WILL BE DEVELOPED TO OBSERVE THE THERMODYNAMIC STRUCTURE, CIRCULATION, AND COMPOSITION OF THE STRATOSPHERE-MESOSPHERE REGION.

RTOP NO. 160-44-56 TITLE: EARTH OBSERVATIONS LABORATORY AND FIELD
EXPERIMENTS AND CALIBRATION OF RADIATION
SENSORS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: HOVIS, W. A. TEL. 301-982-6465

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO DEVELOP NEW TECHNIQUES AND SENSORS TO EXTEND AND IMPROVE REMOTE SENSING FOR METEOROLOGICAL PURPOSES. THIS ENTAILS CONCEPTION OF NEW SENSORS, IMPROVEMENTS OF EXISTING SENSORS, RIGOROUS LABORATORY CALIBRATION AND FIELD TESTS INCLUDING AIRCRAFT AND ROCKET FLIGHTS TO VERIFY THE WORTH AND POTENTIAL OF SUCH SENSORS. THIS EFFORT BEGINS WITH SENSOR COMPONENT DEVELOPMENT SO THAT NEEDED, ADVANCED SENSORS CAN BE BUILT. SENSORS ARE THEN PRODUCED, NORMALLY AS BREADBOARDS, AND ARE EXTENSIVELY TESTED IN THE LABORATORY. EXAMPLES OF SUCH SENSORS ARE HIGH RESOLUTION SCANNING RADIOMETERS AND VERTICAL SOUNDING SPECTROMETERS. LABORATORY TESTS ARE CARRIED OUT THROUGH CALIBRATION AND DEVELOPMENT OF DATA REDUCTION AND HANDLING. AFTER DEVELOPMENT AND LABORATORY TESTS SENSORS WILL BE TESTED IN THE FIELD, ON EITHER AIRCRAFT OR BALLOONS, AND THE RESULTS COMPARED WITH TRUTH MEASUREMENTS TO DETERMINE THE WORTH AND POTENTIAL OF EACH TECHNIQUE. THE RESULTS OF THESE TESTS ARE THEN APPLIED DIRECTLY TO THE METEOROLOGICAL APPLICATIONS FLIGHT PROGRAMS, SUCH AS TOS AND NIMBUS AS NEW EXPERIMENTS TO MEET THE NEEDS OF THE METEOROLOGICAL COMMUNITY.

RTOP NO. 160-44-57 TITLE: AIRBORNE METEOROLOGY PROGRAM

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, L. TEL. 415-961-2280

TECHNICAL SUMMARY

THIS RTOP IS TO PROVIDE AN AIRBORNE PLATFORM, CARRYING INSTRUMENTATION FOR METEOROLOGICAL MEASUREMENTS. EXPERIMENTS WILL BE MOUNTED AND FLOWN ABOARD THE CONVAIR 990 (NASA 711) TO CONDUCT BASIC METEOROLOGICAL STUDIES AND TO SUPPORT SATELLITE INSTRUMENTATION

DEVELOPMENT AND DATA ANALYSIS. A NECESSARY FIRST STEP IN THE DEVELOPMENT OF SATELLITE INSTRUMENTATION FOR REMOTE SENSING OF THE EARTH AND ATMOSPHERE IS TO OBTAIN INFORMATION BASIC TO THE UNDERSTANDING OF FACTORS INFLUENCING THE SPECTRAL SIGNALS TO BE OBSERVED FROM SPACE. THIS INFORMATION MUST BE OBTAINED ABOARD AIRCRAFT BECAUSE MEASUREMENTS MUST BE MADE FROM THE GROUND TO THE STRATOSPHERE WITH SPEED AND FLEXIBILITY IN GEOGRAPHICAL LOCATION TO OBTAIN DATA UNDER THE MANY DESIRED METEOROLOGICAL CONDITIONS. SCALES RANGING FROM LOCAL TO GLOBAL ARE AMENABLE TO STUDY BY AN AIRCRAFT SUCH AS THE CV-990.

RTOP NO. 160-44-58 TITLE: CLIMATOLOGICAL MODELS OF THE ATMOSPHERE
AND CLOUD COVER

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: CAREY, W. T. TEL. 205-453-3424

TECHNICAL SUMMARY

A RESEARCH AND DEVELOPMENT PROGRAM IS REQUIRED TO ESTABLISH METEOROLOGICAL EXPERIMENTS TO OBTAIN EARTH SENSING OBSERVATIONS LEADING TO A BETTER UNDERSTANDING OF SUCH METEOROLOGICAL PROCESSES AS GLOBAL CIRCULATION, MESOSCALE AND MACROSCALE ATMOSPHERIC PHENOMENON, RELATIONSHIP BETWEEN SOLAR AND TERRESTRIAL PHENOMENA AND STATISTICAL METEOROLOGY.

RTOP NO. 160-44-59 TITLE: ATMOSPHERIC TRANSMITTANCE

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BURCHAM, D. P. TEL. 213-354-3028

TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS TASK IS TO IMPROVE THE ACCURACY TO WHICH ATMOSPHERIC TRANSMITTANCES CAN BE CALCULATED FOR SPECIFIC USE IN TEMPERATURE SOUNDING EXPERIMENTS USING THE 4.3 AND 15 MICRON REGIONS OF THE INFRARED SPECTRUM. AT THE PRESENT TIME, THE ACCURACY TO WHICH ATMOSPHERIC TEMPERATURES CAN BE SOUNDED FROM METEOROLOGICAL SATELLITES IS LIMITED BY THE KNOWLEDGE OF THE TRANSMITTANCE OF THE REAL ATMOSPHERE. UNTIL NEWLY DEVELOPED METHODS FOR THE CALCULATIONS OF TRANSMISSION FUNCTIONS HAVE BEEN VERIFIED AGAINST ACTUAL VALUES OF EXTINCTION COEFFICIENTS AND MEASURED VALUES OF ATMOSPHERIC COMPOSITIONS, DETAILED STUDIES OF ATMOSPHERIC TEMPERATURES FROM REMOTE SOUNDERS WILL BE OF LITTLE VALUE TO NUMERICAL WEATHER PREDICTIONS. THIS WORK WILL BE DEVOTED TO DETERMINING THE SHORTCOMINGS OF PRESENT TECHNIQUES BY FURTHER THEORETICAL ANALYSIS, BY DEVELOPING NEW TRANSMISSION CALCULATIONS AND BY MAKING NEW COMPARISONS OF EXISTING AND NEWLY ACQUIRED DATA. THE APPROACH TO THE TASK WILL BE CLOSELY COORDINATED WITH THE NIMBUS TEMPERATURE SOUNDING EXPERIMENTS AND OTHER INTERESTED AGENCIES.

RTOP NO. 160-44-60 TITLE: ATMOSPHERIC EFFECTS UPON REMOTE SENSING
FROM AIRCRAFT AND SATELLITES

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-1111

TECHNICAL SUMMARY

THE PURPOSE IS TO DETERMINE THE EFFECTS OF SPECTRAL TRANSMITTANCE AND VARIABILITY UPON THE QUANTITATIVE INTERPRETATION OF RADIOMETRIC DATA OBTAINED FROM AIRCRAFT AND SPACECRAFT; AND TO DEVELOP ANALYTICAL MODELS FOR SUBSEQUENT CORRECTION AND INTERPRETATION. THE RESEARCH WILL DIRECTLY SUPPORT THE PRESENT NASA EARTH RESOURCES PROGRAM IN THAT THE MEASUREMENTS AND ANALYSES WILL AID THE INTERPRETATION OF MULTISPECTRAL DATA FROM EARTH RESOURCES TECHNOLOGY SATELLITES (ERTS) AND WILL DELINEATE OPTIMUM SPECTRAL REGIONS FOR DETECTION AND IDENTIFICATION OF SELECTED RESOURCE TARGETS. AN ANALYTICAL STUDY WILL BE CONDUCTED IN THE INFRARED TO DETERMINE THE CHARACTERISTICS AND INFLUENCE OF THE ATMOSPHERE ON THE SENSING OF SURFACE TEMPERATURES AND SPECTRAL EMITTANCE SIGNATURES. SPECTRO-RADIOMETRIC MEASUREMENTS OF DIRECT AND SCATTERED SOLAR RADIATION FROM EARTH AND ATMOSPHERE WILL BE PERFORMED OVER THE CONTINUOUS WAVE LENGTH RANGE 0.3 TO 2.5 MICRON AT ALTITUDES FROM GROUND LEVEL TO 50,000 FT. TO TEST THE ANALYTICAL MODEL.

RTOP NO. 160-44-62 TITLE: UTILIZATION OF APOLLO PHOTOGRAPHY FOR
MESOSCALE METEOROLOGY

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: EVANS, D. E. TEL. 713-483-7447

TECHNICAL SUMMARY

OBJECTIVES OF CURRENT AND PROPOSED RESEARCH INVOLVE OBSERVATIONS AND EXPLANATIONS OF DYNAMIC PROCESSES IN THE ATMOSPHERE ON SCALES THAT CANNOT PRESENTLY BE ACCOUNTED FOR IN SYNOPTIC WEATHER FORECASTING SCHEMES AND TECHNIQUE ASSESSMENT FOR FUTURE WEATHER SENSING SYSTEMS. THIS INCLUDES IN DEPTH EXPERIMENTAL ANALYSIS OF DATA COLLECTED BY THE APOLLO, SKYLAB, AND THE EARTH RESOURCES AIRCRAFT PROGRAMS. THE REMOTE SENSING AND IN SITU MEASURED DATA FROM THESE PROGRAMS HAS UNIQUE APPLICATIONS TOWARD SOLVING SOME OF THE NEEDS OF THE GLOBAL ATMOSPHERIC RESEARCH PROGRAM (GARP). THE RESULTS OF THESE STUDIES AS A PART OF GARP WILL INCREASE THE CAPABILITY FOR LONG TERM WEATHER FORECASTING ON A SYNOPTIC SCALE AND WILL INCREASE THE ACCURACY OF SHORT RANGE SMALL SCALE WEATHER FORECASTING (THE SCALE THAT PEOPLE EXPERIENCE WEATHER).

RTOP NO. 160-75-50 TITLE: EARTH RESOURCE SENSING INSTRUMENTATION
ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: GOLDBERG, I. L. TEL. 301-982-6739

TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS TO DEFINE, DEVELOP AND IMPROVE SENSORS AND RELATED INSTRUMENTATION TO DETECT, LOCATE, IDENTIFY, MAP AND MEASURE EARTH RESOURCE PHENOMENA FROM ORBITAL ALTITUDES. INVESTIGATIONS WILL BE MADE OF THE STATE OF REMOTE SENSING TECHNOLOGY AND PERFORMANCE SPECIFICATIONS WILL BE GENERATED FOR IMPROVEMENTS TO

SENSORS AND ANCILLARY EQUIPMENT. STUDIES, PRELIMINARY DESIGNS, FABRICATION AND TESTING OF BREADBOARD AND PRE-PROTOTYPE MODELS WILL BE MADE FOR THOSE ADVANCED SENSORS AND RELATED KEY COMPONENTS THAT ARE APPLICABLE TO THE SATELLITE ASPECT OF THE EARTH RESOURCES PROGRAM.

RTOP NO. 160-75-51 TITLE: CALIBRATION, EVALUATION AND SIMULATION OF
EARTH RESOURCES MULTICHANNEL SURFACE
SENSORS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: HOVIS, W. A. TEL. 301-982-6465

TECHNICAL SUMMARY

THE OBJECTIVE IS TO IMPROVE UPON EXISTING TECHNIQUES FOR THE CALIBRATION OF MULTICHANNEL SENSORS FOR EARTH RESOURCES SENSING, TO EVALUATE AND IMPROVE THE PRESENT SENSORS (ESPECIALLY IN THE AREAS OF OPTIMUM SPATIAL RESOLUTION AND OPTIMUM SPECTRAL BANDS) AND TO SIMULATE MULTICHANNEL SENSOR DATA TO GUIDE IN THE DESIGN OF SENSOR SYSTEMS TO BE DEVELOPED FOR SPACE APPLICATION. CALIBRATION TECHNIQUES ARE BEING DEVELOPED TO RADIOMETRICALLY CALIBRATE LARGE APERTURE SCANNING SENSORS AND VIDICON SYSTEMS IN OVERALL RESPONSE AND RESPONSE FUNCTION WITHIN EACH SPECTRAL BAND. LARGE APERTURE INTEGRATING SPHERES PROVIDING CALIBRATED, DIFFUSE ILLUMINATION AND SPECTROMETER-LIGHT SOURCE COMBINATIONS PROVIDING NARROW SPECTRAL BAND OUTPUT AT KNOWN RADIANCE LEVELS WILL PROVIDE SUCH CALIBRATION. PRESENT SENSORS WILL BE EVALUATED, ESPECIALLY IN THE AREA OF PROPER CHOICE OF SPECTRAL INTERVALS, BY UTILIZING FIELD SPECTROMETER MEASUREMENTS. SETS OF OPTIMUM INTERVALS FOR DISCIPLINES SUCH AS AGRICULTURE, GEOLOGY AND OCEANOGRAPHY WILL BE DEVELOPED TO GUIDE FUTURE SENSOR DESIGN. SENSORS ARE BEING DEVELOPED TO CLOSELY SIMULATE OUTPUT OF SENSORS TO BE FLOWN ON SPACECRAFT TO ALLOW USERS TO COMPARE SPACECRAFT ACQUIRED DATA WITH DATA FROM AREAS OF KNOWN COMPOSITION AND CHARACTER. SUCH SENSORS, CALIBRATED WITH THE PREVIOUSLY MENTIONED SYSTEMS, WILL PROVIDE USERS WITH SIGNATURE BANKS AND EXPERIENCE IN DATA USE.

RTOP NO. 160-75-52 TITLE: DATA MANAGEMENT INFORMATION, EXTRACTION
AND PROCESSING INSTRUMENTATION

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: MAXWELL, M. S. TEL. 301-982-4036

TECHNICAL SUMMARY

FUTURE EARTH OBSERVATION SENSORS ARE BEING DEVELOPED THAT EXHIBIT A MUCH HIGHER RESOLUTION THAN THE PRESENT DEVICES. THE OBJECT OF THIS EFFORT IS TO INVESTIGATE AND DEVELOP DATA MANAGEMENT SYSTEMS THAT WILL SUPPORT THIS INCREASED SENSOR RESOLUTION. DEVELOPMENT OF THIS TECHNOLOGY WILL PROCEED ON SPACECRAFT AND GROUND SYSTEMS. WIDEBAND TAPE RECORDERS AND ON-BOARD DATA PROCESSING ARE THE AREAS OF EFFORT ASSOCIATED WITH THE SPACECRAFT. SMALL RECEIVING SITE SYSTEMS, IMAGE DISPLAYS AND DATA RECORDERS ARE THE AREAS OF EFFORT ASSOCIATED WITH EARTH OBSERVATION GROUND SUPPORT SYSTEMS. CLOSE LIAISON WILL BE MAINTAINED WITH THE RTOP 160-20-52 AND RTOP 160-75-53 PROGRAMS IN ORDER TO MAXIMIZE MUTUAL BENEFITS.

RTOP NO. 160-75-53 TITLE: PRESENTATION, MANIPULATION, VALIDATION
AND RECORDING OF IMAGE DATA

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: KEIPERT, F. A. TEL. 301-982-4930

TECHNICAL SUMMARY

NEW TECHNOLOGY WILL BE DEVELOPED TO GENERATE LARGE VOLUMES OF IMAGE DATA AS PRECISION PROCESSED COLOR COMPOSITES AND AS COMPUTER COMPATIBLE DIGITAL TAPES AT A REASONABLE COST. THE FEASIBILITY OF USING LOW COST VIDEO TAPE RECORDERS AS COMPUTER PERIPHERALS FOR THIS PURPOSE WILL BE INVESTIGATED, AND A COMPUTER DRIVEN COLOR FILM RECORDER WILL BE DEVELOPED. METHODS FOR PROCESSING IMAGE DATA USING COHERENT OPTICAL PROCESSING TECHNIQUES WILL BE DEVELOPED. OPTICAL SYSTEMS FOR THE ANALYSIS OF THE TWO DIMENSIONAL SPECTRA OF ERTS IMAGES AND THE CAPABILITY OF DETECTING INFORMATION USING THOSE SPECTRA WILL BE DEVELOPED. THIS WILL PROVIDE THE CAPABILITY TO REDUCE THE NOISE IN IMAGES AND TO ANALYZE THEIR INFORMATION CONTENT. NEW MACHINE ORGANIZATIONS WILL BE STUDIED TO FIND A SYSTEM ORGANIZATION FOR DIGITAL COMPUTERS WHICH IS SUITED FOR THE PROCESSING OF LARGE VOLUMES OF DIGITAL IMAGE DATA. THE STUDIES WILL BE FOLLOWED BY DEVELOPMENT OF A BREADBOARD MODEL. METHODS OF RADIOMETRIC QUALITY VALIDATION FOR ERTS IMAGES WILL BE INVESTIGATED. TECHNIQUES WILL BE DEVELOPED TO LOCATE THE COORDINATES OF POINTS IN IMAGE DATA WITHOUT THE CONVERSION OF THE DATA TO PHOTOGRAPHS. PRESENTLY USED PHOTO-GRAMMETRIC METHODS ARE TIME CONSUMING AND THE RADIOMETRIC METHODS WHICH ARE BETTER SUITED FOR LARGE DATA VOLUMES HAVE NOT BEEN DEVELOPED FOR ERTS TYPE SENSORS.

RTOP NO. 160-75-54 TITLE: EARTH RESOURCES STUDIES WITH NIMBUS
IMAGERY

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: SHORT, N. M. TEL. 301-982-6603

TECHNICAL SUMMARY

A GROUP AT GSFC CONSISTING OF SPECIALISTS IN GEOLOGY, PEDOLOGY, AGRONOMY, AND DATA PROCESSING SYSTEMS WILL DEVELOP AND CARRY OUT ANALYTICAL PROCEDURES FOR EARTH RESOURCES OBSERVATIONS FROM SATELLITES. IN THE EARLY STAGES OF OPERATION, THE PROJECT WILL EXAMINE AND INTERPRET NIMBUS IMAGERY OF SELECTED LAND AREAS, ESPECIALLY OF THOSE REGIONS FOR WHICH SUPPLEMENTAL AIRCRAFT AND ORBITAL PHOTOGRAPHY AND/OR VARIOUS TYPES OF MAPS (GEOLOGICAL, HYDROLOGICAL, ETC.) ARE AVAILABLE. WHEREVER POSSIBLE, PARTS OF THESE AREAS WILL BE FURTHER INVESTIGATED THROUGH APPROPRIATE ON-SITE FIELD MEASUREMENTS USING SUCH REMOTE SENSORS AS FILTER WEDGE SPECTROMETERS AND MULTI-SPECTRAL PHOTOGRAPHIC CAMERAS. AS SPECIFIC EXPERIENCE IS GAINED IN ANALYSIS OF PHYSICAL AND BIOLOGICAL GROUND FEATURES OBSERVED AT SPATIAL AND SPECTRAL RESOLUTIONS OBTAINABLE FROM THE NIMBUS SYSTEM, THE PROVEN TECHNIQUE WILL BE EXTENDED AND IMPROVED FOR APPLICATION TO ERTS DATA. THUS, THE PRINCIPAL OBJECTIVES ARE: 1) TO EXAMINE AND EVALUATE CLOUD-FREE NIMBUS DATA FOR USE IN ANALYZING LAND SURFACES TO DETERMINE CONTRIBUTIONS OF ROCK AND SOIL TYPES, VEGETATIONAL COVER, SOIL MOISTURE, AND GEOMORPHIC-GEOLOGICAL FEATURES TO VARIATIONS IN REFLECTED AND EMITTED RADIATION; 2) DEVELOP A FIELD OPERATIONAL CAPABILITY AND SUPPORTING LABORATORY PROGRAMS BY WHICH

AREAS OF INTEREST SELECTED FROM NIMBUS INVESTIGATIONS CAN BE STUDIED BY AIR AND GROUND--BASED SURVEYS; AND 3) SPECIFY CRITERIA AND FORMULATE MODELS OF RESOURCES SYSTEMS APPLICABLE TO ERTS PROGRAM, DRAWING UPON REAL CASES WITHIN THESE AREAS, BY WHICH SPACECRAFT, AIRCRAFT AND GROUND INFORMATION CAN BE SUCCESSFULLY CORRELATED.

RTOP NO. 160-75-56 TITLE: HARDWARE FOR HANDLING AIRCRAFT AND SPACECRAFT ACQUIRED DATA

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: EVANS, D. E. TEL. 713-483-7447

TECHNICAL SUMMARY

THE REQUIREMENT TO ACQUIRE AIRCRAFT AND SPACECRAFT DATA AT EXTREMELY HIGH PACKING DENSITIES HAS NECESSITATED THE DEVELOPMENT OF MANY DIVERSIFIED AND SOPHISTICATED DATA ACQUISITION SYSTEMS EMPLOYING A BROAD SPECTRUM OF ENCODING AND FORMATING TECHNIQUES. THE TECHNIQUES EMPLOYED BY THESE SYSTEMS HAS, IN MANY CASES, SURPASSED THE CAPABILITY OF EXISTING DATA CORRELATION AND PROCESSING HARDWARE TO HANDLE THESE DATA IN AN ACCURATE AND TIMELY MANNER. IT IS THEREFORE REQUIRED THAT COMPLIMENTARY TECHNIQUES TO DEVELOPED THAT CAN BE IMPLEMENTED IN EXISTING AND FUTURE AUTOMATIC DATA CORRELATION AND PROCESSING SYSTEMS THAT WILL PERMIT EFFICIENT PROCESSING AND ANALYSIS OF THESE DATA. SPECIFIC AREAS THAT REQUIRE TECHNIQUE DEVELOPMENT INCLUDE: DENSITY ANALYSIS AND REGISTRATION OF MULTIBAND DATA, HYBRID PROCESSING AND AUTOMATIC CORRELATION OF MULTIBAND DATA, AND INFORMATION RETRIEVAL AND DATA MANAGEMENT OF PROCESSED DATA. HARDWARE WILL BE DEVELOPED TO IMPLEMENT THE TECHNIQUES REQUIRED TO PROCESS THESE DATA. STUDIES WILL BE UNDERTAKEN TO DEFINE THE DETAILED SPECIFICATIONS REQUIRED TO DEVELOP, TEST, IMPROVE, AND IMPLEMENT TECHNIQUES, HARDWARE, AND SYSTEMS THAT WILL MEET DATA EXTRACTION AND MANAGEMENT REQUIREMENTS.

RTOP NO. 160-75-57 TITLE: INSTRUMENTS FOR SENSING EARTH RESOURCES FROM AIRCRAFT AND MANNED SPACECRAFT

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: EVANS, D. E. TEL. 713-483-7447

TECHNICAL SUMMARY

THE INTENT OF THIS PORTION OF THE EARTH RESOURCES PROGRAM IS TO INVESTIGATE THE VARIOUS TYPES OF SENSORS AND SYSTEMS FROM AIRCRAFT AND SPACECRAFT AND EVALUATE THEIR UTILITY FOR PROVIDING PERIODIC DATA WHICH WILL ENABLE THE VARIOUS USERS TO CONDUCT THEIR EARTH RESOURCES TASKS MORE EFFICIENTLY. STUDY, DEVELOP, TEST AND IMPROVE SENSORS AND SYSTEMS TO DETECT, IDENTIFY, LOCATE AND MEASURE EARTH RESOURCES PHENOMENA FROM AERIAL AND ORBITAL ALTITUDE. MEASUREMENTS ARE TO BE MADE IN THE MICROWAVE, INFRARED, VISIBLE AND ULTRAVIOLET PORTION OF THE ELECTROMAGNETIC SPECTRUM. THIS TASK IS BEING PERFORMED TO PROVIDE DATA IN DISCIPLINES SUCH AS AGRICULTURE/FORESTRY, GEOGRAPHY, HYDROLOGY, OCEANOGRAPHY AND GEOLOGY TO PROVIDE THE INVESTIGATOR IN THE AREAS WITH DATA FROM WHICH THEY MAY ESTABLISH COMPREHENSIVE MODELS OF ATMOSPHERE, DYNAMIC EARTH, OCEANS AND LAND.

RTOP NO. 160-75-58 TITLE: UNIVERSITY OF MICHIGAN SPECIAL COMPETENCE
GROUP, DATA PROCESSING, AND INFORMATION
EXTRACTION FOR MULTICHANNEL AND RADAR
SENSORS (UV, VISIBLE, IR, AND MW)

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: EVANS, D. E. TEL. 713-483-7447

TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP AND DEMONSTRATE OPTIMUM SYSTEMS FOR EXTRACTION OF INFORMATION FROM MULTICHANNEL SENSOR DATA AND TO PROVIDE FOR SPECIALIZED DATA PROCESSING REQUIRED FOR MULTISPECTRAL SCANNER AND SYNTHETIC APERTURE RADAR DATA. MANY PHYSICAL FACTORS AFFECT REMOTE SENSOR DATA AND LIMIT THE EFFECTIVENESS OF INFORMATION EXTRACTION SCHEMES. ALSO PRESENT METHODS OF INFORMATION EXTRACTION LIMIT THE AREA TO WHICH THEY CAN BE APPLIED. THESE METHODS ARE BASED ON HAVING "GROUND TRUTH" IN THE AREA OF INTEREST. WITH THE ADVENT OF SPACECRAFT-BORNE SENSORS WIDE AREA SURVEYS WILL BE POSSIBLE AND LARGE VOLUMES OF DATA WILL RESULT. TO OVERCOME THE RESTRICTIVENESS OF PRESENT INFORMATION EXTRACTION METHODS A STUDY IS IN PROGRESS TO UNDERSTAND THE PHENOMENA IMPOSING THE LIMITATIONS, DEVELOP DATA PRE-PROCESSING SCHEMES TO ELIMINATE THOSE LIMITATIONS, AND TO APPLY THEM TO ACTUAL SURVEY PROBLEMS. TO OVERCOME THE REQUIREMENT FOR LOCAL "GROUND TRUTH" SPECTRAL SIGNATURES ARE BEING MEASURED AND COLLECTED IN A DATA BANK AT THE MANNED SPACECRAFT CENTER. STUDIES ARE PLANNED TO DEVELOP MATHEMATICAL MODELS TO APPLY THE EFFECTS OF ENVIRONMENTAL INSTRUMENTAL, GEOGRAPHICAL, AND TEMPORAL DIFFERENCES TO THE "LIBRARY" SIGNATURES AND THUS CONSTRUCT SIGNATURES WHICH WILL YIELD RESULTS IN DATA EXTRACTION METHODS IN REMOTE AREA SURVEYS. TO ENABLE PROCESSING OF THE LARGE VOLUME OF DATA HIGHLY EFFICIENT DATA PROCESSING SYSTEMS ARE BEING DEVELOPED TO PERMIT "NEAR-REAL-TIME" DATA PROCESSING. THIS CAPABILITY WILL BE MADE AVAILABLE TO THE USER AGENCIES.

RTOP NO. 160-75-59 TITLE: UNIVERSITY OF KANSAS SPECIAL COMPETENCE
GROUP RADAR DATA APPLICATIONS AND SYSTEMS
STUDIES

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: EVANS, D. E. TEL. 713-483-7447

TECHNICAL SUMMARY

THE OBJECTIVE IS TO CONDUCT STUDIES OF RADAR SYSTEMS TO BE USED IN EARTH ORBITING SPACECRAFT FOR THE PURPOSE OF MAPPING THE GROSS FEATURES OF THE EARTH. TO PROVIDE EVALUATION OF THE USEFULNESS OF THE SPACEBORNE RADAR AS A GEOSCIENCE EXPERIMENT AND MAPPING TOOL FOR STUDY OF EARTH RESOURCES IN THE FIELDS OF GEOLOGY, FORESTRY, GEOGRAPHY, AND OCEANOGRAPHY. SYSTEM STUDIES WILL BE CONDUCTED ON MULTIPLE-POLARIZED RADAR IMAGING SYSTEMS. FEASIBILITY STUDIES OF THE RADAR SYSTEMS ARE PROCEEDING. MANY OF THE PARAMETERS TO BE MEASURED HAVE BEEN IDENTIFIED. DATA ANALYSIS TECHNIQUES ARE BEING CONTINUOUSLY IMPROVED. RADAR DATA IS BEING COLLECTED AND EVALUATED FROM SEVERAL SOURCES: EXISTING RADAR DATA WHERE SOME KNOWLEDGE OF THE TERRAIN STATE AT THE TIME OF IMAGING IS AVAILABLE; CURRENTLY OBTAINED DATA FROM AIRCRAFT-BORNE RADARS WHERE ON SITE TERRAIN STATE IS OBTAINED CURRENTLY WITH OVERFLIGHT; ACOUSTIC MODELING DATA; AND

RADAR DATA OBTAINED FROM GROUND STATION LABORATORY INSTRUMENTATION.

RTOP NO. 160-75-61 TITLE: EARTH RESOURCES DATA ANALYSIS
INSTRUMENTATION AND TECHNIQUES

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: CAREY, W. T. TEL. 205-453-3424

TECHNICAL SUMMARY

TECHNIQUES FOR REMOTE SENSING WILL EVOLVE INTO HIGHLY AUTOMATIC OPERATION OF MULTIBAND SENSING EQUIPMENT TOGETHER WITH COMPUTERS FOR DATA REDUCTION. SYSTEMS AND ORGANIZATIONS NEED TO BE DEVELOPED IN WHICH SENSORS TAKE THE INVENTORY OF EARTH RESOURCES AND PROVIDE AS INPUT DATA TO THE COMPUTER WHICH WILL EVALUATE THESE DATA IN COOPERATION WITH PREPROGRAMMED FACTORS WHICH THEN ARE USED FOR ARRIVING AT OPTIMUM RESOURCE MANAGEMENT DECISIONS. IN ADDITION, THIS AREA, WHICH IS SO CLOSELY COUPLED TO MANY POLITICAL, SOCIOLOGICAL, AND ECONOMIC FACTORS, WILL REQUIRE EFFORTS TO DEVELOP MODELING AND PREDICTION TECHNIQUES TO RELATE THE EFFECTS OF SCIENCE AND ENGINEERING TO HUMAN WELFARE, ECONOMICS AND GEOPOLITICS.

RTOP NO. 160-75-65 TITLE: AGRICULTURE AND FORESTRY REMOTE SENSING
RESEARCH AND TECHNOLOGY

ORGANIZATION: NASA HEADQUARTERS

MONITOR: PARK, A. B. TEL. 202-963-6523

TECHNICAL SUMMARY

THE OBJECTIVE IS TO STUDY, DEVELOP, AND UTILIZE THE UNIQUE MULTISPECTRAL CHARACTERISTICS OF AEROSPACE ACQUIRED REMOTE SENSING DATA IN ORDER TO (1) EFFECTIVELY INCREASE THE UTILIZATION OF, AND CONCOMITANTLY TO (2) DEVELOP A GREATER EFFICIENCY IN THE INVENTORY, PROTECTION, AND MANAGEMENT OF AGRICULTURE, FORESTRY, AND RANGE RESOURCES. THE RESEARCH IS DEVOTED TO SOFTWARE AS WELL AS HARDWARE DEVELOPMENT, INCLUDING UPDATING THE STATE-OF-THE-ART, AND TO SYSTEMS AND METHODS DEVELOPMENT. THE APPROACH UTILIZES MULTISPECTRAL PHOTOGRAPHIC, MULTIPOINT SCANNER, AND THERMAL INFRARED TECHNOLOGY, AS WELL AS PASSIVE AND ACTIVE MICROWAVE RADIOMETRY METHODS, AND VARIOUS BIOPHYSICAL AND BIOCHEMICAL TECHNIQUES FROM GROUND, AERIAL, AND SPACE VEHICLES. COMPUTER PROCESSING AND ANALYSIS TECHNIQUES ARE BEING USED TO SOLVE THE DATA HANDLING PROBLEMS. THIS R&D APPROACH IS PROVIDING A NEW CAPABILITY TO: (1) DETECT AND ASSESS DISEASE, INSECT AND WEED INFESTATION, SALINITY AND MOISTURE STRESS, DROUGHT, AND FIRE; (2) ASSESS CROP AND TIMBER STAND VIGOR TO PREDICT YIELD; (3) DETERMINE SOIL CHARACTERISTICS; (4) IDENTIFY, MAP, AND MEASURE AGRICULTURAL, FORESTRY, AND RANGE LAND USE; (5) ASSESS ENVIRONMENTAL AND ECOLOGICAL CONDITIONS, AND MAN-ENVIRONMENTAL INTERACTIONS.

RTOP NO. 160-75-66 TITLE: SPACECRAFT OCEANOGRAPHY PROJECT
ORGANIZATION: NASA HEADQUARTERS
MONITOR: PARK, A. B. TEL. 202-963-6523
TECHNICAL SUMMARY

SINCE 1965, THE NAVAL OCEANOGRAPHIC OFFICE AND THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HAVE BEEN CONDUCTING, THROUGH A FORMAL WORKING AGREEMENT, A RESEARCH PROGRAM TO DEFINE FEASIBLE OCEAN MEASUREMENTS FROM SPACE PLATFORMS. BROAD CONSIDERATION OF APPLICABLE REMOTE SENSORS TO MEASURE OCEAN FEATURES HAS RESULTED IN A CONCENTRATED EFFORT TO DEFINE THE OCEANOGRAPHIC GOALS FOR THE NEXT SEVERAL YEARS WITH REGARD TO SPACE SYSTEMS. BASICALLY, THIS PROJECT HAS NARROWED FUNDING REQUIREMENTS FOR RESEARCH TO DEFINE SENSOR, OBSERVATIONAL AND DATA REQUIREMENTS FOR A SATELLITE BEARING THE FOLLOWING SYSTEMS: (A) MOCS-MULTICHANNEL OCEAN COLOR SYSTEM, (B) TIMS-THERMAL INFRARED MAPPING SYSTEM, (C) AWODS-ALL WEATHER OCEAN DYNAMICS SYSTEM. THESE SENSOR SYSTEMS WILL OBTAIN DATA ON ALL OCEAN FEATURES EVALUATED TO DATE THE REMOTE SENSING FROM SPACE. THIS PROJECT ALSO RECOGNIZES THE VALUE OF THE DATA COLLECTION SYSTEM (DCS) WHICH HAS BEEN SUCCESSFULLY USED FOR INTERROGATING SURFACE PLATFORMS, AS A COMPLIMENTARY SYSTEM TO REMOTE SENSING. RESEARCH FOR JUSTIFYING AND SPECIFYING THE SENSOR SYSTEMS, OBSERVATIONAL REQUIREMENTS AND DATA HANDLING TECHNIQUES FOR THE ABOVE SYSTEMS IS DIVIDED INTO FIVE CATEGORIES: (1) OCEAN COLOR VIA VISIBLE REGION SENSORS, (2) SEA TEMPERATURE OR THERMAL CHARTING VIA INFRARED (AND MICROWAVE) SENSORS, (3) OCEAN DYNAMICS-PRIMARILY WITH MICROWAVE SENSORS WITH SECONDARY VISIBLE AND INFRARED VISION SENSORS, (4) SPECIFIC OCEAN APPLICATIONS SUCH AS SEA ICE, SHOALS, FOOD-FROM-THE-SEA, POLLUTION AND COASTAL (PROCESSES) ECOSYSTEMS, AND (5) MANAGEMENT. A COHERENT PROGRAM FOR DEVELOPING REQUIREMENTS IN ALL THESE AREAS HAS BEEN PRESENTED TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA). THIS IS THE ONLY NATIONAL EFFORT OF ITS KIND IN OCEANOGRAPHY AS NOT SIMILAR PROGRAMS EXISTS IN THE DEPARTMENT OF DEFENSE, THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION OR ELSEWHERE.

RTOP NO. 160-75-69 TITLE: GEOLOGIC REMOTE SENSING PROGRAM
ORGANIZATION: HEADQUARTERS
MONITOR: PARK, A. B. TEL. 202-963-6523
TECHNICAL SUMMARY

THE GEOLOGIC REMOTE SENSING PROGRAM HAS BEEN COOPERATIVELY SUPPORTED BY NASA AND USGS SINCE FY 65. THE PROGRAM IS AIMED AT 1) DEVELOPING AN IMPROVED UNDERSTANDING OF THE RESPONSE OF SPECIFIC REMOTE SENSORS UNDER VARYING GEOLOGIC AND TERRAIN CONDITIONS, 2) AN EMPIRICAL ANALYSIS OF REMOTE SENSOR DATA ACQUIRED FROM AIRCRAFT AND SPACECRAFT, AND 3) EVALUATING THE USE OF A SATELLITE COMMUNICATION RELAY OF DATA FROM GROUND BASED INSTRUMENTS MONITORING ACTIVE VOLCANOES AND EARTHQUAKE REGIONS. INCREASED EMPHASIS IS BEING PLACED ON THE ADVANTAGES OF SPACEBORNE SENSORS 1) IN SYNOPTICALLY OBSERVING LARGE-SCALE GEOLOGIC FEATURES THAT MAY REVEAL GEOTECTONIC AND GEOMORPHIC RELATIONSHIPS OF REGIONAL OR CONTINENTAL SIGNIFICANCE, AND 2) REPETITIVELY OBSERVING ACTIVE TIME-VARIANT PHENOMENA, SUCH AS NEAR-SHORE CURRENT AND TIDAL PATTERN, AND SEASONAL VARIATION IN VEGETATION AND SNOW COVER THAT MAY BE RELATED TO GEOLOGIC PROCESSES

OR MAY ENHANCE SOME GEOLOGIC FEATURES. RECENT PROGRESS INCLUDES 1) A SOILS ASSOCIATION MAP OF 117,000 SQUARE MILES IN THE SOUTHWESTERN U.S., COMPILED FROM GEMINI PHOTOS, AND SHOWING A CONSISTENCY BETWEEN MAPPED UNITS NOT AVAILABLE ON MAPS COMPILED BY CONVENTIONAL MEANS; 2) A RADAR MOSAIC OF THE ENTIRE STATE OF MASSACHUSETTS THAT REVEALS SEVERAL STRUCTURAL RELATIONSHIPS NOT GENERALLY RECOGNIZED HERETOFORE; 3) SUCCESSFUL AUTOMATIC MAPPING OF 9 TERRAIN UNITS IN YELLOWSTONE PARK USING DATA FROM AN AIRBORNE IMAGING RADIOMETER AND DIGITAL COMPUTER PROCESSING; 4) AN FM TRANSMITTER HAS BEEN USED SUCCESSFULLY TO TRANSMIT SEISMIC DATA WITH EXCELLENT RELIABILITY MORE THAN 45 KILOMETERS FROM AN ACTIVE REGION OF THE SAN ANDREAS FAULT ZONE.

RTOP NO. 160-75-70 TITLE: HYDROLOGY, USDI
ORGANIZATION: NASA HEADQUARTERS
MONITOR: DEUTSCH, M. TEL. 202-382-4423
TECHNICAL SUMMARY

THE HYDROLOGIC PROBLEMS HAVE BEEN DIVIDED INTO 4 STUDY CLASSES: (1) INLAND HYDROLOGIC FEATURES, (2) QUANTITIES AND PHYSICAL PROPERTIES OF SNOW AND ICE (3) ESTUARINE AND COASTAL HYDROLOGIC FEATURES AND (4) WATER QUALITY PARAMETERS. THE PURPOSE OF THE HYDROLOGY PROGRAM IS TO DEVELOP APPLICATIONS OF REMOTE SENSOR TECHNOLOGY IN THE SOLUTION OF WATER RESOURCES PROBLEMS AND TO DEVELOP AN AUTOMATED DATA COLLECTION, PROCESSING, ANALYSIS AND DISTRIBUTION NETWORK UTILIZING BOTH REMOTE SENSOR (AIR AND SPACE) AND GROUND CONTROL DATA. A REAL-TIME NETWORK OF GROUND MONITOR STATIONS WILL BE SELECTED FROM ABOUT 50,000 DATA COLLECTION STATIONS PRESENTLY MAINTAINED BY THE USGS WATER RESOURCES DIVISION IN COOPERATION WITH ALL 50 STATES, AND NUMEROUS FEDERAL, INTERSTATE AND LOCAL AGENCIES.

RTOP NO. 160-75-71 TITLE: GEOGRAPHY, URBAN, REGIONAL & ENERGY
BUDGET CHANGE DETECTION AND PREDICTION
ORGANIZATION: NASA HEADQUARTERS
MONITOR: PARK, A. B. TEL. 202-963-6523
TECHNICAL SUMMARY

THE USGS GEOGRAPHIC APPLICATIONS PROGRAM FOR REMOTE SENSING HAS BEEN REDESIGNED TO CARRY OUT SUPPLEMENTAL RESEARCH ON REMOTE SENSING TECHNOLOGY AND DATA APPLICATIONS THAT WILL ASSIST THE USGS IN ESTABLISHING A SOLID FOUNDATION FOR A NATIONAL, REGIONAL, AND URBAN LAND USE DATA BANK, PROGRAMMED TO IDENTIFY TRENDS AND IMPROVE THE ACCURACY OF PREDICTIONS. THE EXPERIMENTAL PROJECTS PLANNED AND INITIATED, WITH FINANCIAL ASSISTANCE FROM NASA DURING THE LATTER PART OF 1970, CONSTITUTE CLOSELY INTER-RELATED SEGMENTS OF PREPARATIONS FOR AN OPERATIONAL PROGRAM TO BE UNDERTAKEN BY THE USGS WHEN ITS FEASIBILITY HAS BEEN DETERMINED. THE FY 1971 PROGRAM INCLUDES A SEQUENCE OF EXPERIMENTS IN THE DETECTION, IDENTIFICATION, AND MEASUREMENT OF URBAN AND REGIONAL CHANGES, INCLUDING SURFACE ENERGY BUDGET CONDITIONS, IDENTIFIABLE WITH APPROPRIATELY INSTRUMENTED, HIGH ALTITUDE AIRCRAFT AS WELL AS WITH ERTS-A AND SUBSEQUENT EARTH RESOURCES SATELLITE SYSTEMS. THE PROGRAM WILL FIRST INVOLVE MONITORING CHANGES IN THE LAND USE OF FOUR SELECTED CITIES AND FOUR

REGIONS. THESE CITIES AND REGIONS HAVE BEEN SELECTED TO OBTAIN A MAXIMUM VARIETY OF ENVIRONMENTAL CONDITIONS AND, IN COMBINATION, TO SERVE AS A PILOT STUDY FOR THE COUNTRY AS A WHOLE. THE RESULTANT DATA WILL BE INTEGRATED IN ATLAS FORMAT TO ANALYZE TRENDS AND CAUSAL FACTORS. THE RESULTS OF THAT GEOGRAPHIC ANALYSIS WILL THEN BE USED TO DEVELOP AND APPLY MODELS TO MAKE PREDICTIONS AND PROVIDE BASES FOR POLICY GUIDANCE IN URBAN, REGIONAL, AND ENVIRONMENTAL MANAGEMENT. WITH THE ASSISTANCE OF RB-57 OVERFLIGHTS, AND THE ANTICIPATED RETURNS FROM ERTS AND OTHER SATELLITES, LAND USE DATA WILL BE PLOTTED ON BASE MAPS AT SCALES OF APPROXIMATELY 1:100,000 FOR URBAN AREAS AND 1:250,000 FOR REGIONS. LAND USE CLASSIFICATION SCHEMES DEVELOPED UNDER GEOGRAPHIC APPLICATIONS PROGRAM CONTRACTS DURING THE PAST SEVERAL YEARS WILL BE UTILIZED AND THE RESULTANT DATA PROCESSED FOR MACHINE STORAGE, RETRIEVAL, AND DISPLAY IN MAP OR TABULAR FORM.

RTOP NO. 160-75-73 TITLE: NATURAL AND CULTURAL RESOURCE MANAGEMENT
(SAR)

ORGANIZATION: NASA HEADQUARTERS

MONITOR: PARK, A.

TEL. 202-133-6523

TECHNICAL SUMMARY

DEPARTMENT OF INTERIOR BUREAUS ARE PROGRESSING ON FEASIBILITY STUDIES OF THE APPLICATION OF EARTH RESOURCES SATELLITE DATA AND ASSOCIATED SPACE TECHNOLOGY TO OPERATIONAL FUNCTIONS OF THE DEPARTMENT. THESE STUDIES ARE IN EIGHT BROAD TASK AREAS EACH CONSISTING OF SEVERAL DISCRETE PROJECTS: 1. LAND CLASSIFICATION FOR RECLAMATION PLANNING AND MANAGEMENT, INCLUDING WATER LOGGED IRRIGATION LAND, TROPICAL LAND IRRIGATION CLASSIFICATION, ARID LAND WEATHER MODIFICATION, WATER AND LAND RESOURCES FOR CLASSIFICATION OF ARID IRRIGATION LANDS, WEED CONTROL FOR IRRIGATION MANAGEMENT, WATER QUALITY FLOW FOR IRRIGATION, INTENSE RAINSTORMS AND WATER MANAGEMENT DEVELOPMENT OF SYSTEM FOR UTILIZING ERTS DATA FOR RECLAMATION, SOIL ENGINEERING, AND IMPROVED SNOW SURVEY. 2. LAND USE CLASSIFICATIONS AND RESOURCE INVENTORIES FOR MULTI-BUREAU REQUIREMENTS INCLUDING APPLICATION OF SPACE SYSTEMS TO PUBLIC LAND INVENTORIES, PUBLIC TIMBER AND SPRUCE BEETLE CONTROL, RESOURCE INVENTORY OF PAPAGO INDIAN RESERVATION, USE OF ERTS DATA BY COMPUTER FOR INDIAN AFFAIRS, AND CADASTRAL SURVEYS OF PUBLIC LANDS. 3. OIL LEAKS AND SLICKS, INCLUDING APPLICATIONS OF NASA'S FRAUNHOFER LINE DISCRIMINATOR TO OIL AND WATER POLLUTION PROBLEMS. 4. ECOLOGY OF WETLANDS AND UPLANDS WILDLIFE HABITAT AREAS, INCLUDING USE OF ERTS DATA FOR WILDLIFE REFUGEE MANAGEMENT, AND THE USE OF SPACE IMAGERY AND TECHNOLOGY FOR GAME AREAS AND COASTAL ZONE FISH AND CRUSTACEAN BREEDING AREAS ECOLOGY STUDIES. 5. INVENTORY, PRESERVATION, MANAGEMENT OF NATIONAL PARKS USING SPACE TECHNOLOGY, AND INCLUDING ARCHAEOLOGICAL SITE DEVELOPMENT.

RTOP NO. 160-75-74 TITLE: PURDUE APPLICATIONS ANALYSIS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: EVANS, D. E. TEL. 713-483-7447
TECHNICAL SUMMARY

THE LABORATORY FOR APPLICATIONS OF REMOTE SENSING AT PURDUE UNIVERSITY HAS DEVELOPED A NUMBER OF TECHNIQUES FOR ANALYSIS OF MULTISPECTRAL SCANNER DATA. THE PATTERN RECOGNITION TECHNIQUES FOR FEATURE CLASSIFICATION HAVE BEEN SHOWN TO BE VERY EFFECTIVE FOR AGRICULTURAL APPLICATIONS, AND INITIAL INVESTIGATION HAS SHOWN THAT THE SAME TECHNIQUES WILL BE VERY USEFUL FOR OTHER EARTH RESOURCES DISCIPLINES AS WELL. MISSIONS WILL BE FLOWN TO COLLECT DATA THROUGHOUT THE YEAR TO DETERMINE THE SIGNATURE OF AGRICULTURAL CROPS THROUGH THE GROWING SEASON, AND TO COLLECT DATA PERTAINING TO OTHER DISCIPLINES AS WELL. TECHNIQUES WILL BE DEVELOPED FOR ANALYZING THE DATA FROM ALL DISCIPLINES. STUDIES WILL BE CONDUCTED TO DETERMINE ACCEPTABLE TECHNIQUES FOR DIGITAL REGISTRATION OF MULTIBAND PHOTOGRAPHY, APPLICATION OF PATTERN RECOGNITION TECHNIQUES TO SPACE-ACQUIRED PHOTOGRAPHY. AN IBM 360/67 COMPUTER WILL BE ACQUIRED AND FIVE REMOTE TERMINALS WILL BE ESTABLISHED TO PERMIT OTHER INSTALLATIONS TO USE THE PROGRAMS AND TECHNIQUES PREVIOUSLY DEVELOPED BY PURDUE. PURDUE WILL ASSIST MSC IN THE CHECKOUT OF THE 24 BAND MULTISPECTRAL SCANNER.

RTOP NO. 160-75-75 TITLE: PUBLIC HEALTH ECOLOGY
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: BARNES, C. M. TEL. 713-483-4251
TECHNICAL SUMMARY

THE PUBLIC HEALTH ECOLOGY PROGRAM IS DESIGNED TO DETERMINE THROUGH SEVERAL PILOT STUDIES THE USEFULNESS OF AIRCRAFT AND ULTIMATELY SATELLITE REMOTE SENSING IN DEFINING PUBLIC HEALTH PROBLEMS AND SUGGESTING REMEDIES THROUGH A GROSS GEOPATHOLOGIC ANALYSIS. SPECIFICALLY, NASA MULTISPECTRAL SENSING DATA WILL BE USED IN DETERMINING ENVIRONMENTAL POLLUTION OF WATER AND AIR AND HOW THESE POLLUTANTS AFFECT THE HEALTH OF THE LOCAL POPULACE. INSECT GROWTH AS RELATED TO LOCAL CLIMATOLOGICAL CONDITIONS WILL BE STUDIED AND PLANS DEVELOPED FOR ASSISTING ERADICATION OFFICIALS IN COMBATING THESE PLAGUES.

RTOP NO. 160-75-76 TITLE: LASER RADAR MEASUREMENTS OF THE MARINE
ATMOSPHERE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-3285
TECHNICAL SUMMARY

THIS RESEARCH DEALS WITH THE THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF LASER RADAR AS A MEANS OF REMOTELY SENSING THE MARINE ENVIRONMENT. IT INVOLVES THE DEVELOPMENT OF EXPERIMENTAL APPARATUS; PERFORMANCE OF EXPERIMENTAL MEASUREMENTS IN THE MARINE ATMOSPHERE AND BENEATH THE SEA, AND DEVELOPMENT OF THEORETICAL MODELS AND ANALYSES. EMPHASIS WILL BE PLACED ON THE FOLLOWING MEASUREMENTS:
MONOCHROMATIC TRANSMISSIVITY OF MARINE ATMOSPHERE AND SEA WATER AT

DIFFERENT LASER WAVELENGTHS; SPATIAL DISTRIBUTION OF SEA SALTS, AEROSOLS AND MOLECULAR DENSITIES; CONSTITUENT DENSITY DISTRIBUTIONS, ESPECIALLY WATER VAPOR; AND CLOUD FORMATION AND DISTRIBUTIONS. THIS RESEARCH IS EXPECTED TO PROVIDE NEW MEASUREMENT TECHNIQUES FOR STUDYING THE MARINE ATMOSPHERE AND WILL THEREBY CONTRIBUTE TO THE BASIC UNDERSTANDING OF THE AIR-SEA INTERACTION PROBLEM AND OF THE MARINE ENVIRONMENT, IN GENERAL. IN ADDITION, IT SHOULD PROVIDE INFORMATION ON ATMOSPHERIC TRANSMISSIVITY WHICH IS NEEDED TO FURTHER RESEARCH ON REMOTE SENSING OF SEA-SURFACE TEMPERATURE BY SATELLITES.

RTOP NO. 160-75-77 TITLE: DEVELOPMENT OF CHESAPEAKE BAY ECOLOGICAL TEST SITE FOR REMOTE SENSING APPLICATIONS

ORGANIZATION: NASA WOLLOPS STATION

MONITOR: BETTLE, J. F. TEL. 703-824-3411

TECHNICAL SUMMARY

A BROAD, LONG-RANGE PROGRAM WILL BE PURSUED TO ESTABLISH AND DEVELOP THE CHESAPEAKE BAY AS AN AREA IN WHICH MANY POTENTIAL APPLICATIONS OF REMOTE SENSING FROM AIRCRAFT AND SPACECRAFT CAN BE EVALUATED AND CALIBRATED, IN PARTICULAR THOSE INVOLVING LAND-SEA INTERFACES. EFFORTS AND PLANS WILL BE DIRECTED AT MAKING THE BAY AREA A MULTIDISCIPLINARY TEST SITE ABOUT WHICH A SUBSTANTIAL INFORMATION CENTER CAN BE DEVELOPED. THIS INFORMATION WILL BE ACQUIRED FROM SUBSURFACE, SURFACE, AIRCRAFT, AND EVENTUAL EARTH RESOURCES SATELLITE OBSERVATIONS. INFORMATION RESULTING FROM WORK WITHIN, AND THE EXCHANGE AND INTERACTION BETWEEN, THESE PROGRAM OBJECTIVES WILL STRONGLY AID IN THE DEVELOPMENT OF TECHNIQUES FOR UNDERSTANDING AND MANAGING ECOLOGICAL PARAMETERS IN THE CHESAPEAKE BAY AREA. THE DEVELOPMENT OF THE SITE WILL PROVIDE A TEST-BED FOR EARTH RESOURCE EXPERIMENTS AND A CALIBRATION AND GROUND TRUTH AREA FOR EARTH SURVEY SPACE SYSTEMS. THE DEVELOPED TECHNOLOGY CAN BE EXTENDED TO OTHER GEOGRAPHICAL AREAS ON AN OPERATIONAL BASIS.

RTOP NO. 160-75-78 TITLE: DEVELOPMENT OF REMOTE-SENSING TECHNIQUES TO DETERMINE WATER QUALITY

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-1111

TECHNICAL SUMMARY

THE PURPOSE IS TO DEVELOP REMOTE SENSING TECHNIQUES WHICH CAN BE USED TO STUDY THE PRODUCTIVITY, TOXICITY AND TURBIDITY OF WATER BODIES. THE STUDIES WILL PROVIDE A DATA BASE FROM WHICH TO EVALUATE LOCAL AND GLOBAL EFFECTS ON MARINE ECOLOGY DUE TO MAN-MADE AND NATURAL POLLUTANTS. APPLICATIONS WILL INCLUDE RAPID DETERMINATION OF PHOTOSYNTHESIS-INDUCED PRODUCTIVITY OVER LARGE REGIONS OF THE OCEANS, SURVEYS OF WATER QUALITY FOLLOWING POLLUTION ABATEMENT ACTION, DETERMINATION OF PRESENCE AND EXTENT OF A SURFACE FILM AS A TOXIC AGENT AND BARRIER TO OXYGEN TRANSPIRATION, AND DELINEATION OF TIDAL INTRUSIONS, CURRENTS, AND WATER BODY BOUNDARIES. AIRBORNE MEASUREMENTS WILL BE PERFORMED TO EVALUATE INSTRUMENTATION SUCH AS A RECENTLY DEVELOPED DIFFERENTIAL RADIOMETER SYSTEM (DRS) FOR OPERATIONAL USE IN DETERMINING CHLOROPHYLL, TURBIDITY AND SURFACE

FILMS THROUGH UNIQUE REFLECTANCE OR POLARIZATION CHARACTERISTICS. LABORATORY STUDIES WILL BE CONDUCTED, FOR EXAMPLE, OF THIN FILMS ON THE SURFACE OF WATER UTILIZING ELLIPSOMETRY (POLARIZATION SPECTROSCOPY) TECHNIQUES. MODIFICATION OF THESE TECHNIQUES TO THE REMOTE IDENTIFICATION OF COMPLEX POLLUTANT FILMS ON THE SURFACE OF REAL BODIES OF WATER WILL BE INVESTIGATED.

RTOP NO. 160-75-79 TITLE: REMOTE SENSING OF EARTH AND ATMOSPHERE
FROM AIRCRAFT

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, L. TEL. 415-961-2280

TECHNICAL SUMMARY

THIS RTOP IS TO PROVIDE AIRBORNE PLATFORMS FOR REMOTE SENSING OF RADIATION FROM THE EARTH AND ATMOSPHERE. SUCH OBSERVATIONS HAVE APPLICATIONS IN THE FIELDS OF GEOLOGY, GEOGRAPHY, AGRICULTURE, FORESTRY, HYDROLOGY, OCEANOGRAPHY, AND AIR POLLUTION. SATELLITES CAN BE USED TO OBTAIN SOME OF THESE DATA; HOWEVER, AIRCRAFT HAVE THE UNIQUE CAPABILITY FOR RAPID DEPLOYMENT TO GEOGRAPHICAL LOCATIONS OF INTEREST, CONTINUOUS MONITORING OF THE TARGET AREA, AND MONITORING UNDER CLOUD COVER AND OZONE LAYERS WITH HIGH RESOLUTION.

RTOP NO. 160-79-51 TITLE: EARTH DYNAMICS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: SMITH, D. TEL. 301-982-4555

TECHNICAL SUMMARY

THE PROGRAM PLANS TO INVESTIGATE THE ESTABLISHMENT OF REFERENCE COORDINATE SYSTEMS BY THE USE OF PRECISE RANGING OF SATELLITES AND VERY LONG BASELINE INTERFEROMETRY. THESE REFERENCE SYSTEMS ARE REQUIRED IN THE STUDY OF BOTH THE SHORT AND LONG TERM DYNAMICS OF THE EARTH WHICH IT IS INTENDED TO INVESTIGATE. THE HARDWARE REQUIREMENTS FOR PRECISION SATELLITE TRACKING WILL BE DETERMINED AND THE DEVELOPMENT OF PRECISE TRAJECTORY DETERMINATION SYSTEMS WILL CONTINUE. HARMONIC COEFFICIENTS OF THE EARTH'S GRAVITATIONAL FIELD ARE BEING DETERMINED FROM SATELLITE ORBIT DATA AND THE INCLUSION OF GROUND BASED GRAVITY MEASURES IS INTENDED. THE ANALYSIS IS BEING PREPARED FOR THE DETERMINATION OF TIDAL PARAMETERS FOR THE SOLID EARTH AND FOR THE MEASUREMENT OF THE MOTION OF THE POLE OF ROTATION OF THE EARTH. AN EXPERIMENT FOR THE MEASUREMENT OF THE ROTATION RATE OF THE EARTH IS BEING PLANNED AND STUDIES OF THE POSSIBLE MEASUREMENT OF CONTINENTAL DRIFTS AND THE RELATIONSHIPS BETWEEN POLAR MOTION AND OTHER GEOPHYSICAL PHENOMENA ARE INTENDED.

RTOP NO. 160-79-52 TITLE: EARTH OBSERVATIONS ADVANCED STUDIES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BURKE, J. D. TEL. 213-354-6363

TECHNICAL SUMMARY

THE OBJECTIVE OF EARTH OBSERVATIONS ADVANCED STUDIES IS TO PROVIDE INFORMATION IN ADVANCE OF PROJECT COMMITMENTS WHICH WILL

ASSIST IN PLANNING FUTURE FLIGHT PROGRAMS AND RELATED ACTIVITIES IN THE AREAS OF EARTH RESOURCES SURVEY, METEOROLOGY, AND EARTH PHYSICS AND PHYSICAL OCEANOGRAPHY. THE FIRST OBJECTIVE OF THESE STUDIES IN FY '71 WILL BE TO DEVELOP A RATIONALE AND A PLAN FOR AN EARTH PHYSICS AND PHYSICAL OCEANOGRAPHY PROGRAM. THIS PLAN SHOULD CLEARLY DELINEATE WHERE WE ARE HEADED IN THE EARTH PHYSICS DISCIPLINE, AS WELL AS CLEARLY IDENTIFYING THE PRACTICAL GOALS TOWARD WHICH WE ARE HEADING. THE PLAN SHOULD RECOGNIZE THAT THERE ARE SIGNIFICANT TRADE-OFFS BETWEEN SMALL INCREMENTAL PROGRAMMATIC STEPS AND LARGER, HIGHER-RISK STEPS. THIS PLAN SHOULD EMPHASIZE THE RATIONALE FOR AND EXPECTED ACCOMPLISHMENTS OF FUTURE SPACE MISSIONS IN EARTH PHYSICS; FOR EXAMPLE, DRAG-FREE MISSIONS AND OCEAN SURFACE GEOMETRY-ORIENTED MISSIONS. THE STARTING POINT FOR THIS PLAN SHOULD BE SELECTED PORTIONS OF THE FINDING AND REQUIREMENTS OUTLINED IN NASA REPORT CR 1579, ENTITLED "THE TERRESTRIAL ENVIRONMENT: SOLID EARTH AND OCEAN PHYSICS." (REFERENCE 1) THIS IS CONSIDERED AS A NECESSARY FIRST STEP. THE EARTH SURVEYS PLANNING DOCUMENTATION OF APRIL 1969 SHOULD ALSO BE USED A REFERENCE. THE SECOND OBJECTIVE OF THE FY '71 STUDIES WILL BE TO CONDUCT A CONCEPTUAL MISSION REQUIREMENTS STUDY OF THE DRAG-FREE SATELLITE MISSION AS A COMPONENT OF A RELATED SERIES OF EARTH PHYSICS SATELLITES (EPS). THIS CONCEPTUAL MISSION REQUIREMENTS STUDY SHOULD INCLUDE A RATIONALE FOR THESE MISSIONS IN THE CONTEXT OF THE OVERALL PLAN AND RATIONALE CONTAINED IN THE FIRST OBJECTIVE.

RTOP NO. 160-79-53 TITLE: EARTH OBSERVATIONS PROGRAMS OFFICE
SUPPORT ASSIGNMENT

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: NEWBERRY, A. W. TEL. 213-354-3220

TECHNICAL SUMMARY

TO ASSIGN ONE JPL PROFESSIONAL TO THE EARTH OBSERVATIONS PROGRAMS OFFICE AT NASA HEADQUARTERS FOR APPROXIMATELY ONE YEAR TO PARTICIPATE IN SPACE FLIGHT APPLICATIONS TASKS AS DIRECTED BY THE DIRECTOR OF EARTH OBSERVATIONS PROGRAMS. A SENIOR MEMBER OF THE JPL TECHNICAL STAFF, WHOSE INTERESTS AND BACKGROUND ARE COMPATIBLE WITH THE REQUIRED FUNCTIONS, IS NOMINATED FOR THE ASSIGNMENT AND, IF ACCEPTED, MOVES TO WASHINGTON, D. C. FOR THE AGREED PERIOD. DURING THIS RESIDENT ASSIGNMENT HE ASSISTS AND ADVISES THE HEADQUARTERS OFFICE TO WHICH HE IS ATTACHED, AS ASSIGNED AND WITHIN HIS AREA OF COMPETENCE. SIMILAR ASSIGNMENTS IN MAL AND OSSA/SL HAVE PROVED MUTUALLY BENEFICIAL.

RTOP NO. 160-79-54 TITLE: PHYSICAL OCEANOGRAPHY

ORGANIZATION: WALLOPS STATION

MONITOR: STANLEY, H. R. TEL. 703-824-3411

TECHNICAL SUMMARY

THIS OCEAN PHYSICS PROGRAM WILL PROVIDE A FRAMEWORK FOR THE PLANNING OF EXPERIMENTS WHICH CAN UTILIZE SPACE TECHNOLOGY AND RELATED PRECISION DISTANCE MEASUREMENT TECHNIQUES TO ADVANCE THE UNDERSTANDING OF THE DYNAMICS OF THE WORLD'S OCEANS. REMOTE SENSING FROM SATELLITES WILL EFFICIENTLY AND ECONOMICALLY YIELD INVALUABLE

INFORMATION CONCERNING THE PHYSICAL SEA SURFACE, MASS TRANSPORT, AIR-SEA INTERFACE, WAVE CHARACTERISTICS; AND GEODETIC POSITIONING AT SEA. THE INITIAL STUDIES WILL INVOLVE THREE DISTINCT TECHNIQUES FOR DETERMINING THE CORRELATION BETWEEN SEA-STATE AND ELECTROMAGNETIC WAVE SCATTERING. THIS CORRELATION MUST BE DETERMINED IF MEANINGFUL RESULTS ARE TO BE OBTAINED FROM AN ORBITING RADAR ALTIMETER. A STUDY IS ALSO PROPOSED WHEREBY A SURVEY WILL BE MADE ON REQUIREMENTS AND AVAILABILITY OF SPACECRAFT AND OCEANOGRAPHIC INSTRUMENTATION. AFTER THE ABOVE DATA HAVE BEEN COMPILED AND CORRELATED WITH GROUND TRUTH, TOTAL MISSION PLANS MAY BE FORMULATED TO ENSURE MAXIMUM BENEFITS FROM MINIMUM EXPENDITURES.

RTOP NO. 160-79-55 TITLE: IMPROVED OCEAN GEODESY
ORGANIZATION: WALLOPS STATION
MONITOR: TOWNSEND, W. F. TEL. 703-824-3411
TECHNICAL SUMMARY

IMPROVED OCEAN GEODESY PROGRAM WILL INVESTIGATE METHODS AND TECHNIQUES FOR SATISFYING IMMEDIATE AND FUTURE REQUIREMENTS IN THE AREAS OF SHIP POSITIONING, NAVIGATION, ESTABLISHMENT OF MARINE GEODETIC CONTROL NETWORKS, SATELLITE ALTIMETER GROUND TRUTH, OCEAN FLOOR MAPPING, GEOIDAL MAPPING, AND CONTROL FOR GLOBAL AND REGIONAL EARTH RESOURCES. INITIALLY EMPHASIS WILL BE PLACED ON THE USE OF THE WALLOPS RANGE RECOVERER SHIP AND, THE GSFC APOLLO SHIP TO SERVE AS TEST PLATFORMS FOR THE EVALUATION OF CURRENTLY AVAILABLE TRACKING, NAVIGATION, AND BATHYMETRIC INSTRUMENTATION. A SERIES OF CONTROLLED EXPERIMENTS WILL BE PERFORMED USING THE APOLLO TRACKING SHIP VANGUARD TRACKING OF THE GEOS-2, GEOS-C, TRANET AND POSSIBLY OTHER SATELLITES BY THE SHIP AND A NETWORK OF GROUND STATIONS. SHIP ACOUSTIC RANGING TO UNDERWATER TRANSPONDERS WILL BE PERFORMED SIMULTANEOUSLY WITH THE SATELLITE TRACKING. IT WILL THEN BE POSSIBLE TO EVALUATE THE SHIPBORNE CAPABILITIES FROM A COMPLETE SYSTEM VIEWPOINT AS WELL AS FROM AN INDIVIDUAL INSTRUMENT SYSTEM VIEWPOINT. THE INFORMATION GATHERED WILL PROVIDE REAL LIFE ESTIMATES OF HOW WELL A SHIP CAN POSITION ITSELF USING SATELLITE DATA, HOW WELL IT CAN LOCATE (IN THE GEODETIC SENSE) AN ARRAY OF ACOUSTIC CONTROL POINTS ON THE OCEAN FLOOR, HOW WELL THE VARIOUS SYSTEMS CAN BE CALIBRATED AND MAINTAINED AND FINALLY, HOW WELL VARIOUS GEODETIC PARAMETERS CAN BE ESTIMATED. THIS, IN TURN, WILL DEVELOP DESIGN CRITERIA FOR THE IMPROVEMENT OF CURRENT INSTRUMENTATION AND TECHNIQUES TO MEET THE FUTURE REQUIREMENTS OF MARINE GEODESY SUCH AS AUTOMATED NAVIGATION AND MAPPING OF THE TIME VARIABILITY OF THE OCEAN FLOOR.

RTOP NO. 160-79-55 TITLE: IMPROVED OCEAN GEODESY
ORGANIZATION: WALLOPS STATION
MONITOR: TOWNSEND, W. F. TEL. 703-824-3411
TECHNICAL SUMMARY

IMPROVED OCEAN GEODESY PROGRAM WILL INVESTIGATE METHODS AND TECHNIQUES FOR SATISFYING IMMEDIATE AND FUTURE REQUIREMENTS IN THE AREAS OF SHIP POSITIONING, NAVIGATION, ESTABLISHMENT OF MARINE GEODETIC CONTROL NETWORKS, SATELLITE ALTIMETER GROUND TRUTH, OCEAN

FLOOR MAPPING, GEODAL MAPPING, AND CONTROL FOR GLOBAL AND REGIONAL EARTH RESOURCES. INITIALLY EMPHASIS WILL BE PLACED ON THE USE OF THE WALLOPS RANGE RECOVERER SHIP AND THE GSFC APOLLO SHIP TO SERVE AS TEST PLATFORMS FOR THE EVALUATION OF CURRENTLY AVAILABLE TRACKING, NAVIGATION, AND BATHYMETRIC INSTRUMENTATION. A SERIES OF CONTROLLED EXPERIMENTS WILL BE PERFORMED USING THE APOLLO TRACKING SHIP VANGUARD TRACKING OF THE GEOS-2, GEOS-C, TRANET AND POSSIBLY OTHER SATELLITES BY THE SHIP AND A NETWORK OF GROUND STATIONS. SHIP ACOUSTIC RANGING TO UNDERWATER TRANSPONDERS WILL BE PERFORMED SIMULTANEOUSLY WITH THE SATELLITE TRACKING. IT WILL THEN BE POSSIBLE TO EVALUATE THE SHIPBORNE CAPABILITIES FROM A COMPLETE SYSTEM VIEWPOINT AS WELL AS FROM AN INDIVIDUAL INSTRUMENT SYSTEM VIEWPOINT. THE INFORMATION GATHERED WILL PROVIDE REAL LIFE ESTIMATES OF HOW WELL A SHIP CAN POSITION ITSELF USING SATELLITE DATA, HOW WELL IT CAN LOCATE (IN THE GEODETIC SENSE) AN ARRAY OF ACOUSTIC CONTROL POINTS ON THE OCEAN FLOOR, HOW WELL THE VARIOUS SYSTEMS CAN BE CALIBRATED AND MAINTAINED AND FINALLY, HOW WELL VARIOUS GEODETIC PARAMETERS CAN BE ESTIMATED. THIS, IN TURN, WILL DEVELOP DESIGN CRITERIA FOR THE IMPROVEMENT OF CURRENT INSTRUMENTATION AND TECHNIQUES.

RTOP NO. 160-79-61 TITLE: PRECISION SATELLITE TRACKING

ORGANIZATION: WALLOPS STATION

MONITOR: SELSER, A. R. TEL. 703-824-3411

TECHNICAL SUMMARY

THIS PROJECT HAS TWO BASIC AIMS: (1) TO INSURE THAT ALTIMETER TECHNOLOGY AND SUPPORTING TECHNOLOGIES ARE SUFFICIENTLY ADVANCED TO MEET SATELLITE ALTIMETRY OBJECTIVES AS THEY ARISE FOR THE GEOS-C AND FOLLOW ON PROGRAMS, AND (2) TO INSURE THE FULL UTILIZATION OF SATELLITE ALTIMETRY DATA IN SEA SURFACE MAPPING, ORBIT DETERMINATION, AND GRAVITY ANOMALY INVESTIGATIONS FOR WHICH SUCH DATA PROVIDE UNIQUE INFORMATION. THE MAIN AREAS OF INVESTIGATION ARE THE DEVELOPMENT OF ALTIMETER HARDWARE, DEVELOPMENT OF TECHNIQUES FOR ALTIMETER CALIBRATION, AND EVALUATION AND THE ANALYSIS OF THE RELATIONSHIP BETWEEN ALTIMETER MEASUREMENTS AND MODELED GEOPOTENTIAL PARAMETERS. THE PROBLEMS OF DEVELOPING SATELLITE ALTIMETERS CAPABLE OF 1 METER AND 10 CENTIMETERS ARE INVESTIGATED AND DEFICIENCIES IN PRESENT SYSTEMS ARE IDENTIFIED. A LONG RANGE (10 YEAR) PLAN WILL BE DEVELOPED FOR SOLVING THE DEVELOPMENT PROBLEMS THAT MAY BE ENCOUNTERED. METHODS FOR PROVIDING ACCURATE ORBITS FOR THE VARIOUS ALTIMETER REQUIREMENTS WILL BE STUDIED AND EVALUATED. THESE STUDIES WILL INCLUDE THE DEVELOPMENT OF COMPUTATIONAL TOOLS FOR PROVIDING MEANINGFUL ALTIMETER ERROR ANALYSES AND MISSION PLANNING. PROCEDURES WILL THEN BE ESTABLISHED FOR ALTIMETER CALIBRATION AND OCEAN SURFACE MAPPING. FINALLY, ANALYSIS WILL BE MADE OF THE UTILIZATION OF ALTIMETER DATA FOR IMPROVED ORBIT DETERMINATION AND THE IMPROVEMENT OF GEODETIC PARAMETERS.

RTOP NO. 160-79-61 TITLE: PRECISION SATELLITE TRACKING
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THIS RTOP COVERS TASKS ASSOCIATED WITH THE DEVELOPMENT OF AN OPTICAL INTERFEROMETRIC SYSTEM FOR PRECISION TRACKING OF A SYNCHRONOUS SPACECRAFT. SUCH AN OPTICAL INTERFEROMETER, COUPLED WITH AN APPROPRIATE ORBIT DETERMINATION PROGRAM, WILL PROVIDE INFORMATION WHICH WILL ALLOW DETERMINATION OF SEVERAL GEOPHYSICAL PARAMETERS: EARTH TIDES AND STRAINS, POLE MOTION, EPHEMERIS PARAMETERS, AND CONTINENTAL DRIFT. THE BASIC GOAL IS THE DEVELOPMENT OF AN OPERATIONAL SYSTEM FOR ACCURATE DETERMINATION OF THE LOCATION OF SPECIFIC POINTS ON THE EARTH'S SURFACE, WITH RESIDUAL ERRORS BEING IN THE DECIMETER RANGE. THE SYSTEM BEING CONSIDERED IS BASED ON A DOUBLE APERTURE, DIVISION OF WAVEFRONT TYPE OF OPTICAL INTERFEROMETER. THE SYSTEM OPERATES AT THE CARBON DIOXIDE LASER WAVELENGTHS; IT REQUIRES A 200 WATT CARBON DIOXIDE LASER TRANSMITTER, A SPACECRAFT BORNE PASSIVE RETROREFLECTOR, AND A DOUBLE APERTURE HETERODYNE RECEIVER WITH A BASELINE OF APPROXIMATELY 100 METERS. THE ENTIRE SYSTEM WOULD BE TRANSPORTABLE SO THAT IT COULD BE MOVED FROM PLACE-TO-PLACE FOR SYSTEMATIC DRIFT MEASUREMENTS. MOST OF THE COMPONENTS AND DEVICES NECESSARY TO DEVELOP AN OPERATIONAL SYSTEM ALREADY EXIST. THE PRIMARY ACTIVITY FOR FY-71 WILL BE DIRECTED TOWARD DEMONSTRATING THE POTENTIAL OF SUCH OPTICAL INTERFEROMETRIC METHODS, AND TO CONCENTRATE ON THE FOLLOWING SUBTASKS: 1. A DETAILED SYSTEM STUDY OF A DOUBLE APERTURE PRECISION OPTICAL TRACKING SYSTEM. 2. A STUDY OF METHODS FOR IMPROVEMENT OF EXISTING CARBON DIOXIDE LASER HETERODYNE RECEIVERS. 3. A STUDY OF ATMOSPHERIC TURBULENCE EFFECTS UPON INFRARED RADIATION. 4. A STUDY OF A SPACE QUALIFIED INFRARED RETROREFLECTOR (COVERED PARTLY BY THIS RTOP AND PARTLY BY AN AAFE PROPOSAL).

RTOP NO. 160-79-61 TITLE: PRECISION SATELLITE TRACKING
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: PLOTKIN, H. H. TEL. 301-982-5503
TECHNICAL SUMMARY

OBJECTIVE IS DEVELOPMENT, TEST, DEPLOYMENT, AND EVALUATION OF ADVANCED LASER INSTRUMENTS AND SYSTEMS FOR EARTH PHYSICS AND GEODESY PROGRAMS. IN PARTICULAR, IN RESPONSE TO SPECIFIC REQUIREMENTS OF THE EARTH PHYSICS AND GEODESY PROGRAMS, (A) THIS RTOP WILL IMPROVE THE ACCURACY AND PRECISION OF LASER SATELLITE TRACKING OVER THAT PRESENTLY ACHIEVED, INCREASE THE DATA RATE, EXTEND THE TRACKING RANGE, AND SIMPLIFY THE GROUND STATION FOR ECONOMY AND RELIABILITY; (B) A LONG BASE-LINE LASER INTERFEROMETER GROUND STATION WILL BE DEVELOPED, WHICH, WHEN USED WITH SPACECRAFT LASER BEACONS, PASSIVE REFLECTORS, OR INFRARED STELLAR SOURCES, CAN ACHIEVE ANGLE-MEASURING PRECISION OF BETTER THAN 10 TO THE MINUS 8TH POWER RADIANS; (C) IT WILL APPLY LASER RANGING TECHNIQUES TO DEVELOPMENT OF SPACEBORNE LASER ALTIMETERS CAPABLE OF 10 CM PRECISION ABOVE THE OCEAN AND STUDY OF THE SEA SURFACE STATE. IN FY71, LASERS BASED UPON NEODYMIUM DOPING IN YAG (YTTRIUM-ALUMIUM GARNET) OR IN GLASS WILL BE INCORPORATED INTO SATELLITE TRACKING SYSTEMS AND WILL BE TESTED IN

FY72. THIS CAN POTENTIALLY INCREASE PRECISION AND DATA RATE OVER RUBY LASERS BY AN ORDER OF MAGNITUDE. TRACKING OF LUNAR REFLECTORS USING SMALLER TRANSMITTING TELESCOPES WILL BE DEVELOPED. APPLICATION OF SPACEBORNE ND:YAG LASER TO ALTIMETRY AND SEA-STATE OBSERVATIONS WILL BE STUDIED. AN INFRARED INTERFEROMETER COMPOSED OF TWO COHERENT CARBON-DIOXIDE LASER RECEIVING STATIONS SEPARATED BY AS MUCH AS 10 TO THE 9TH POWER WAVELENGTHS (10 KM) WILL ALSO BE STUDIED AS A NEW POWERFUL TOOL IN EARTH PHYSICS. ITS PRECISION IN MEASURING POLE WANDER AND ROTATIONAL IRREGULARITIES MAY EXCEED 0.001 ARC SECOND.

RTOP NO. 160-79-61 TITLE: PRECISION SATELLITE TRACKING

ORGANIZATION: WALLOPS STATION

MONITOR: SELSER, A. R. TEL. 703-824-3411

TECHNICAL SUMMARY

THIS PROJECT HAS TWO BASIC AIMS: (1) TO INSURE THAT ALTIMETER TECHNOLOGY AND SUPPORTING TECHNOLOGIES ARE SUFFICIENTLY ADVANCED TO MEET SATELLITE ALTIMETRY OBJECTIVES AS THEY ARISE FOR THE GEOS-C AND FOLLOW ON PROGRAMS, AND (2) TO INSURE THE FULL UTILIZATION OF SATELLITE ALTIMETRY DATA IN SEA SURFACE MAPPING, ORBIT DETERMINATION, AND GRAVITY ANOMALY INVESTIGATIONS FOR WHICH SUCH DATA PROVIDE UNIQUE INFORMATION. THE MAIN AREAS OF INVESTIGATION ARE THE DEVELOPMENT OF ALTIMETER HARDWARE, DEVELOPMENT OF TECHNIQUES FOR ALTIMETER CALIBRATION, AND EVALUATION AND THE ANALYSIS OF THE RELATIONSHIP BETWEEN ALTIMETER MEASUREMENTS AND MODELED GEOPOTENTIAL PARAMETERS. THE PROBLEMS OF DEVELOPING SATELLITE ALTIMETERS CAPABLE OF 1 METER AND 10 CENTIMETERS ARE INVESTIGATED AND DEFICIENCIES IN PRESENT SYSTEMS ARE IDENTIFIED. A LONG RANGE (10 YEAR) PLAN WILL BE DEVELOPED FOR SOLVING THE DEVELOPMENT PROBLEMS THAT MAY BE ENCOUNTERED. METHODS FOR PROVIDING ACCURATE ORBITS FOR THE VARIOUS ALTIMETER REQUIREMENTS WILL BE STUDIED AND EVALUATED. THESE STUDIES WILL INCLUDE THE DEVELOPMENT OF COMPUTATIONAL TOOLS FOR PROVIDING MEANINGFUL ALTIMETER ERROR ANALYSES AND MISSION PLANNING. PROCEDURES WILL THEN BE ESTABLISHED FOR ALTIMETER CALIBRATION AND OCEAN SURFACE MAPPING. FINALLY, ANALYSIS WILL BE MADE OF THE UTILIZATION OF ALTIMETER DATA FOR IMPROVED ORBIT DETERMINATION AND THE IMPROVEMENT OF GEODETIC PARAMETERS.

RTOP NO. 160-79-64 TITLE: VERY LONG BASELINE RADIO INTERFEROMETRY (VLBI)

ORGANIZATION: JET PROPULSION LAB

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

TASKS ASSOCIATED WITH DEVELOPING VERY LONG BASELINE RADIO INTERFEROMETRY (VLBI) ARE COVERED BY THIS RTOP. THESE HIGHLY ACCURATE MEASUREMENTS TAKEN OVER A PERIOD OF TIME CAN PROVIDE SIGNIFICANT ADVANCES IN THE STATE OF OUR KNOWLEDGE OF CERTAIN GEOPHYSICAL PARAMETERS - CONTINENTAL DRIFT, EARTH TIDES, POLE MOTION, UTL AND EARTH EPHEMERIS PARAMETERS (PROCESSION/NUTATION AND OBLIQUITY RATE) AS WELL AS THE LOCATION OF THE RADIO SOURCES WHICH ARE BEING TRACKED (WHETHER EXTRA GALACTIC RADIO NOISE SOURCES OR SPACECRAFT).

KNOWLEDGE IN THESE AREAS, NOTABLY THE GEOPHYSICAL PARAMETERS WILL HOPEFULLY BE A SIGNIFICANT CONTRIBUTION TO OUR UNDERSTANDING OF THE EARTH (INTERIOR AS WELL AS EXTERIOR) AND TO THE SUCCESSFUL PREDICTION/CONTROL OF EARTHQUAKES. ALTHOUGH IT IS ASSUMED THAT THE VLBI PROGRAM WILL LEAD TO AN OPERATIONAL SYSTEM PRODUCING DATA WHICH WILL AID IN THE ANALYSIS OF THE SHORT AND LONG TERM DYNAMICS OF THE EARTH, THE FY71 EFFORTS WILL BE DIRECTED TOWARD DEMONSTRATING THE POTENTIAL OF VLBI AND WILL CONCENTRATE ON THE FOLLOWING SUBTASKS: A.

PERFORM VLBI FEASIBILITY DEMONSTRATIONS FOR GEOPHYSICAL APPLICATIONS. B. DEVELOP SOFTWARE FOR VLBI DATA REDUCTION AND ANALYSIS. C. COMPARE VLBI PERFORMANCE AGAINST RESULTS OBTAINED FROM TECHNIQUES SUCH AS SPACECRAFT TRACKING AND THE LUNAR LASER CORNER REFLECTOR. D. DETERMINE VLBI INHERENT ACCURACY LIMITATIONS/CAPABILITIES INCLUDING VLBI SPACECRAFT TRACKING AND THE DETERMINING OF SHIP POSITION AT SEA.

RTOP NO. 160-79-64 TITLE: VERY LONG BASE LINE INTERFEROMETRY: RADIO ORGANIZATION: WALLOPS STATION

MONITOR: WEST, W. W. TEL. 703-824-3411

TECHNICAL SUMMARY

THE PURPOSE OF THIS PROJECT IS TO ATTACK AND SOLVE, IN ORDER OF CRITICALITY, PROBLEMS INVOLVED WITH THE APPLICATION OF VERY LONG BASE LINE INTERFEROMETRIC TECHNIQUES TO THE INVESTIGATION OF THE DYNAMICS OF THE SOLID EARTH. A SERIES OF CONCURRENT EXPERIMENTS ARE PROPOSED TO INVESTIGATE PROPAGATION ERROR SOURCES; IDENTIFICATION, OBSERVATION AND CATALOGING OF RADIO SOURCES; IMPROVEMENTS IN REDUCTION, ANALYSIS, AND CALIBRATION TECHNIQUES; AND INSTRUMENTATION AND TIMING ERROR CRITERIA FOR VLBI TECHNOLOGY. WALLOPS HAS AVAILABLE A WIDE VARIETY OF LARGE APERTURE, MULTIFREQUENCY, MICROWAVE ANTENNAS TO SERVE AS AN INSTRUMENTATION BASE FOR THE PERFORMANCE OF THE EXPERIMENTS. SOME OF THE WALLOPS INSTRUMENTATION IS DUPLICATED ON THE WEST COAST OF THE U.S. SO THAT WALLOPS EXPERIMENT RESULTS WILL BE DIRECTLY APPLICABLE TO THE WEST COAST SITE. THIS FORMS A VLBI SYSTEM AT INTERCONTINENTAL RANGE CONSISTING OF MATCHED EQUIPMENT WITH FREQUENCY DIVERSITY. THESE EXPERIMENTS ARE DESIGNED TO PROVIDE A REALISTIC ERROR BUDGET FOR VLBI SYSTEMS AND WILL DEMONSTRATE THE FEASIBILITY OF USING CURRENT MICROWAVE SYSTEMS AS VLBI GEODETIC INSTRUMENTATION. EXPERIMENT RESULTS WILL INDICATE CRITICAL ERROR SOURCES AND SHOULD PROVIDE ALTERNATIVE SOLUTIONS TO ELIMINATE OR COMPENSATE FOR THESE PROBLEMS.

RTOP NO. 160-79-64 TITLE: VERY LONG BASELINE RADIO INTERFEROMETRY ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: CLARK, T. A. TEL. 301-982-5957

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO DEVELOP THE TECHNIQUES OF VERY LONG BASELINE INTERFEROMETRY (VLBI) TO THE POINT THAT PRECISE GEODETIC, ASTROMETRIC AND RELATIVITY MEASUREMENTS CAN BE MADE WITH AN OPERATIONAL NETWORK. THIS NETWORK SHOULD CONSIST OF A NUMBER OF INDEPENDENT STATIONS EQUIPPED WITH DISH ANTENNAS CAPABLE OF OBSERVING

BOTH NATURAL RADIO SOURCES (QUASI-STELLAR OBJECT = QSO) AND MAN-MADE SOURCES IN THE FREQUENCY RANGE 1-10 GHZ, PLUS A CENTRAL PROCESSING FACILITY WHERE THE DATA TAKEN AT THE STATIONS IS CROSS-CORRELATED. THE INITIAL GOALS OF THESE OBSERVATIONS WILL BE TO: (1) ESTABLISH THE LENGTH AND ORIENTATION OF BASELINE VECTOR CONNECTING PAIRS OF STATIONS TO ACCURACIES OF PLUS OR MINUS 1 METER AND PLUS OR MINUS 0.01 SECONDS OF ARC OR BETTER; (2) ESTABLISH THE ASTROMETRIC LOCATIONS OF A NUMBER OF QSO'S IN AN INERTIAL FRAME TO PLUS OR MINUS 0.01 SECONDS OF ARC OR BETTER;

RTOP NO. 160-79-66 TITLE: OCEAN PLATFORM POSITIONING

ORGANIZATION: WALLOPS STATION

MONITOR: KRABILL, W. B. TEL. 703-824-3411

TECHNICAL SUMMARY

THE PURPOSE OF THIS PROJECT IS TO DEMONSTRATE, BY ACTUAL EXPERIMENTATION, THE PRESENT CAPABILITIES OF EXISTING DISTANCE MEASURING TECHNOLOGY TO POSITION OCEAN PLATFORMS TO AN ACCURACY OF 100 METERS OR BETTER. THE INFORMATION DERIVED FROM THESE EXPERIMENTS WILL BE USED TO DEFINE EXPERIMENTS TO EVALUATE THE CAPABILITY OF DETERMINING SHIP/PLATFORM VELOCITIES TO 5 CM/SEC. STUDIES WILL BE PERFORMED AND EXPERIMENTS CONDUCTED TO EXPAND OCEAN FLOOR POSITIONING TECHNOLOGY. THE RESULTS OF THESE STUDIES WILL BE USED TO DEFINE DESIGN AND PERFORMANCE SPECIFICATIONS FOR ADVANCED PLATFORM POSITIONING SYSTEMS. A SERIES OF EXPERIMENTS ARE PLANNED USING THE WALLOPS RANGE RECOVERER SHIP AND THE GSFC APOLLO TRACKING SHIP VANGUARD AS TEST PLATFORMS FOR THE EVALUATION OF CURRENTLY AVAILABLE TRACKING, NAVIGATION, AND BATHYMETRIC INSTRUMENTATION. THE DATA FROM THESE EXPERIMENTS WILL BE REDUCED AND ANALYZED IN SEVERAL DIFFERENT MODES TO PROVIDE SURFACE POSITIONING INFORMATION, PLATFORM VELOCITY INFORMATION, AND BOTTOM TRANSPONDER POSITIONING. DATA FROM LAND BASED RADARS, SHIPBORNE RADAR, SHIPBORNE ACOUSTIC DME SYSTEMS, INERTIAL NAVIGATION SYSTEMS, AND OTHER NAVIGATION SYSTEMS WILL BE EVALUATED. IT WILL THEN BE POSSIBLE TO EVALUATE THE POSITIONING CAPABILITY FROM A TOTAL SYSTEM VIEWPOINT AND TO BETTER DEFINE ADVANCED SYSTEM CRITERIA.

RTOP NO. 160-79-67 TITLE: DATA MANAGEMENT

ORGANIZATION: WALLOPS STATION

MONITOR: LEITAO, C. D. TEL. 703-824-3411

TECHNICAL SUMMARY

THE EARTH PHYSICS DATA MANAGEMENT PROGRAM WILL DEVELOP SPECIFICATIONS FOR THE ESTABLISHMENT OF A CENTRALIZED, AUTOMATED DATA COLLECTION STATION WHICH ACCEPTS PRECISION MEASUREMENTS FROM SATELLITES AND OTHER SOURCES, SUBJECTS THE DATA TO ANALYSIS BY MODELS OF THE ACTIVE EARTH AND OCEANIC CIRCULATION AND PROVIDES A NEAR REAL TIME CAPABILITY FOR THE PREDICTION OF POTENTIALLY HAZARDOUS GEOPHYSICAL PHENOMENA. DATA MAINTAINED AT THIS FACILITY WILL BE AVAILABLE FOR INSPECTION AND ANALYSIS THROUGH TIME SHARING REMOTE FACILITIES. THE DEFINITION OF THESE SPECIFICATIONS WILL BE THE FINAL STAGE OF A THREE PHASE DEVELOPMENT. DURING THE INITIAL STAGE ALL

SOURCES OF PRIMARY AND SECONDARY DATA APPROPRIATE TO GEOPHYSICAL INVESTIGATIONS SHALL BE IDENTIFIED AND A MATRIX OF SOURCES AND AVAILABLE PARAMETERS WILL BE CONSTRUCTED. THE DATA ELEMENTS REQUIRED BY EXISTING EARTH MODELS WILL BE CATEGORIZED AND THE GENERAL REQUIREMENTS FOR A DATA MANAGEMENT SYSTEM WILL BE ESTABLISHED. IN THE SECOND STAGE OF DEVELOPMENT, A DATA MANAGEMENT MODEL WILL BE CONSTRUCTED, APPLICABLE EARTH MODELS MODIFIED, AND A PILOT PROGRAM IMPLEMENTED. THROUGH THE USE OF SIMULATION AND SECONDARY DATA, A RETROSPECTIVE PREDICTIVE CAPABILITY WILL BE CONSTRUCTED AND FUTURE DATA REQUIREMENTS WILL BE DEFINED. THE FINAL PHASE WILL CONSIST OF A REVIEW OF THE PILOT PROGRAM AND THE SPECIFICATION OF THE REQUIREMENTS FOR NEAR REAL TIME PREDICTION SYSTEM.

RTOP NO. 160-79-67 TITLE: VLBI: DATA MANAGEMENT
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BRIGLIO, A. TEL. 213-354-6137
TECHNICAL SUMMARY

THE LONG RANGE OBJECTIVE OF THIS PLAN IS TO DEVELOP A PROTOTYPE DATA PROCESSING SYSTEM DESIGNED TO AID THE GEOPHYSICS EXPERIMENTOR AND SCIENTIST. THE SYSTEM WILL BE VALUABLE FOR THE SCIENTIST TO DEVELOP AND ANALYZE MODELS OF THE ACTIVE EARTH. IT WILL ALSO AID THE SCIENTIST IN HIS ABILITY TO PREDICT SUCH VIOLENT GEOPHYSICAL PHENOMENA AS VOLCANOS, EARTHQUAKES, TSUNAMIS, ETC. THIS PLAN IS TO BE APPROACHED THROUGH TWO RELATED TASKS. ONE TASK IS THAT OF DETERMINING THE DATA PROCESSING NEEDS OF THE DEVELOPMENT OF MATHEMATICAL MODELS OF THE ACTIVE EARTH USING DATA DERIVED FROM EARTH SATELLITES AND OTHER SOURCES. THE SECOND TASK CARRIES OUT THE DEVELOPMENT AND EVALUATION OF AN EXPERIMENTAL DATA PROCESSING SYSTEM WHICH EFFICIENTLY COLLECTS DATA RELATED TO GEOPHYSICAL PHENOMENA, ORGANIZES, STORES, AND PROCESSES IT, WHICH SIMULTANEOUSLY PROVIDES THE SCIENTIST WITH THE ABILITY TO PERFORM ON-LINE EXPERIMENTATION.

RTOP NO. 160-79-68 TITLE: LOW ALTITUDE SATELLITE MAGNETOMETRY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: SIRY, J. W. TEL. 301-982-5905
TECHNICAL SUMMARY

INVESTIGATIONS WILL BE MADE OF THE VALUE OF LOW-ALTITUDE OBSERVATORY SYSTEMS, SYNCHRONOUS SATELLITE SYSTEMS, AND SATELLITES AT OTHER ALTITUDES IN CONNECTION WITH MEETING A VARIETY OF SCIENTIFIC AND RELATED APPLICATIONS OBJECTIVES. AMONG THE SCIENTIFIC DISCIPLINES INVOLVED ARE GEODESY, OCEAN PHYSICS, GEOMAGNETISM, ATMOSPHERIC PHYSICS, AND IONOSPHERIC PHYSICS. THE ASSOCIATED TECHNOLOGICAL PROGRAMS INCLUDE THE DEVELOPMENT AND USE OF SATELLITE-TO-SATELLITE TRACKING SYSTEMS, SATELLITE ALTIMETER SYSTEMS, AND DRAG-FREE SATELLITE SYSTEMS. IN THE FIELD OF GEODESY, FOR EXAMPLE, THE GRAVITATIONAL FIELD OF THE EARTH WILL BE STUDIED IN TWO WAYS, BY SATELLITE-TO-SATELLITE TRACKING OF LOW-ALTITUDE OBSERVATORY SPACECRAFT ORBITING IN THE 250 TO 300 KILOMETER ALTITUDE RANGE, AND BY MEANS OF SATELLITE-BORNE ALTIMETERS OPERATING IN THESE SPACECRAFT. THESE SAME ALTIMETERS WILL ALSO BE USED FOR OCEAN PHYSICS

INVESTIGATIONS INCLUDING SEA STATE STUDIES AND SURVEYS OF THE OCEAN SURFACE TOPOGRAPHY. ULTIMATELY, THE GEODESY AND OCEAN PHYSICS PROGRAMS TOGETHER MAY YIELD SOME INFORMATION ABOUT THE RELATIONSHIP BETWEEN THE GEOID AND THE OCEAN SURFACE. SUCH KNOWLEDGE WOULD BE VALUABLE IN CONNECTION WITH STUDIES OF CURRENTS, TSUNAMIS, STORM SURGES, ETC. THE LOW-ALTITUDE OBSERVATORY SPACECRAFT WILL ALSO PROVIDE AN IDEAL PLATFORM ON WHICH TO MOUNT MAGNETOMETERS FOR THE STUDY OF THE EARTH'S MAGNETIC FIELD. CORRELATIONS BETWEEN FEATURES OF THE EARTH'S GRAVITATIONAL AND MAGNETIC FIELDS WILL BE SOUGHT. SATELLITES ORBITING AT 250 TO 300 KILOMETERS ALTITUDE WHICH ARE DRAG CALIBRATED ON DRAG COMPENSATING, I.E., DRAG-FREE, ALSO PROVIDE USEFUL PLATFORMS FOR THE STUDY OF THE ATMOSPHERE AND THE IONOSPHERE.

RTOP NO. 160-90-01 TITLE: INSTITUTIONAL SUPPORT
ORGANIZATION: GODDARD INSTITUTE FOR SPACE STUDIES
MONITOR: ABID, G. E. TEL. 301-982-4551
TECHNICAL SUMMARY

THE GODDARD INSTITUTE FOR SPACE STUDIES IS CHARGED WITH THE CONDUCT OF THEORETICAL RESEARCH IN METEOROLOGY, GEOPHYSICS, AND ASTRONOMY WITH EMPHASIS ON ATMOSPHERIC DYNAMICS & CONVECTION. HISTORICALLY THE INSTITUTE'S CIVIL SERVICE STAFF HAS BEEN AUGMENTED BY RESOURCES OF THE COMMERCIAL SEGMENT OF THE ECONOMY TO PROVIDE NECESSARY SUPPORT FUNCTIONS. THE INSTITUTE'S PROGRAM INCLUDES BASIC STUDIES IN THEORIES OF TURBULENCE, CONVECTION & RADIATIVE TRANSFER. THE INSTITUTE PROVIDES A WORKING LIAISON BETWEEN NASA AND THE ACADEMIC COMMUNITY BY CARRYING OUT ITS PROGRAMS IN CLOSE ASSOCIATION WITH UNIVERSITIES IN THE NEW YORK METROPOLITAN AREA IN ORDER TO STIMULATE THE INTEREST OF FACULTY MEMBERS AND STUDENTS IN THE AREA OF RESEARCH RELEVANT TO THE NASA PROGRAM. THE INSTITUTE ASSISTS IN THE ANALYSIS AND INTERPRETATION OF DATA GATHERED BY SCIENTIFIC SATELLITES AND PROVIDES GENERAL ASSISTANCE AND SUPPORT TO GODDARD AND NASA HEADQUARTERS IN SPACE SCIENCES ACTIVITIES.

RTOP NO. 160-90-02 TITLE: NATIONAL SPACE SCIENCE DATA CENTER
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: VETTE, J. I. TEL. 301-982-2354
TECHNICAL SUMMARY

THE NATIONAL SPACE SCIENCE DATA CENTER (NSSDC) WAS ESTABLISHED TO FURTHER THE WIDEST PRACTICABLE USE OF REDUCED DATA OBTAINED FROM SPACE SCIENCE INVESTIGATIONS AND TO PROVIDE INVESTIGATORS WITH AN ACTIVE REPOSITORY FOR SUCH DATA. AS SUCH, IT IS RESPONSIBLE FOR THE ACTIVE COLLECTION, ORGANIZATION, STORAGE, ANNOUNCEMENT, RETRIEVAL, DISSEMINATION, AND EXCHANGE OF DATA RECEIVED FROM SATELLITE EXPERIMENTS, SOUNDING-ROCKET PROBES, AND HIGH-ALTITUDE AERONAUTICAL AND BALLOON INVESTIGATIONS. IN ADDITION, THE DATA CENTER COLLECTS CORRELATIVE DATA, SUCH AS MAGNETOGRAMS AND IONOGRAMS, FROM GROUND-BASED OBSERVATORIES AND STATIONS FOR NASA INVESTIGATORS AND FOR ONSITE USE AT NSSDC IN THE ANALYSIS AND EVALUATION OF SPACE SCIENCE EXPERIMENTAL RESULTS. THE DATA CENTER PROVIDES DUPLICATE COPIES OF REDUCED EXPERIMENTAL DATA ON REQUEST. WITHIN THE

CAPABILITIES OF NSSDC, THE DATA MAY BE CONVERTED TO ANOTHER MEDIUM TO MEET THE NEEDS OF THE REQUESTER.

RTOP NO. 164-06-50 TITLE: COMMUNICATIONS SYSTEMS ANALYSIS

ORGANIZATION: JET PROPULSION LAB.

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

THE INCREASING DEMAND FOR THE USE OF EARTH ORBITING COMMUNICATION SATELLITES TO SERVE AS DATA LINKS FOR HANDLING DIVERSE FORMS OF INFORMATION IS PLACING NEW TECHNOLOGICAL, ECONOMIC, AND ADMINISTRATIVE BURDENS ON THE SYSTEM DESIGNS. A SPECIFIC PRICE PAID IN ORDER TO ACHIEVE HIGH QUALITY IN PRESENT COMMUNICATION SATELLITE SYSTEMS IS THAT OF BANDWIDTH AND THE NEED FOR PRECISE SYNCHRONIZATION. FOR YEARS, BECAUSE THE FIELD OF SPACE COMMUNICATIONS HAS BEEN LIMITED TO RELATIVELY FEW USERS, THE PROBLEM OF BANDWIDTH CONSERVATION HAS BEEN RELATIVELY UNIMPORTANT; HOWEVER, WHEN THE MULTITUDE OF SMALL USER REQUIREMENTS IS CONSIDERED, BANDWIDTH, AND THE POWER NECESSARY TO ACHIEVE THAT BANDWIDTH, BECOMES ACUTE. THE OBJECTIVE OF SUBJECT RESEARCH EFFORT IS TO STUDY A CLASS OF TECHNIQUES WHICH WILL PROVIDE A MEANS OF ACHIEVING RELIABLE AND EFFICIENT COMMUNICATIONS IN AN ENVIRONMENT WHERE SPECTRUM CONSERVATION AND EASE OF SYNCHRONIZATION, COUPLED WITH MULTIPLE AND DIVERSE REQUIREMENTS, IS THE UNDERLYING CONSIDERATION. THE WORK WILL DRAW UPON THE HIGHLY SUCCESSFUL TECHNOLOGY DEVELOPED FOR DEEP SPACE COMMUNICATIONS. EMPHASIS WILL BE PLACED ON THE MODULATION (SIGNAL SET DESIGN) APPROACH TO BANDWIDTH AND POWER CONSERVATION. FOUR IDENTIFIABLE AREAS EMERGE WORTHY OF CONSIDERATION: 1) THE FURTHER DEVELOPMENT OF THE CAPACITY AND REALIZATION OF PEAK AND AVERAGE POWER CONSTRAINED COMMUNICATION CHANNELS, 2) DEVELOPMENT OF TECHNIQUES AKIN TO SINGLE-SINGLEBAND ANGLE MODULATION, 3) THE STUDY OF THE PARAMETRIC AND NON-PARAMETRIC NATURE OF THE CHANNELS, AND 4) EFFICIENT RECEIVER AND SYNCHRONIZATION TOPOLOGIES. THE STATED EFFORT IS INTENDED TO ARRIVE AT SYSTEMS DESIGN WHICH EFFICIENTLY UTILIZED POWER AND BANDWIDTH. INVOLVED ALSO IS A CAREFUL ASSESSMENT OF THE IMPLEMENTATION TRADE-OFFS OF "ANALOG" AND "DIGITAL" PROCESSING METHODS IN LIGHT OF THE ADVANCING TECHNOLOGY. THE OBJECTIVES WILL BE ACHIEVED BY ANALYSIS AND DESIGN ACTIVITIES THAT ARE SUPPORTED BY EXPERIMENTAL SIMULATION. ALL OF THE EFFORT WILL BE ACCOMPLISHED IN-HOUSE. THE TECHNICAL APPROACH WILL BE TO BUILD ON AND EXTEND THE FY'70 ACCOMPLISHMENTS FROM BOTH THE 164-21 AND 125-21 PROGRAMS.

RTOP NO. 164-06-50 TITLE: COMMUNICATION SYSTEMS ANALYSIS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: MILLER, J. E. TEL. 301-982-5885

TECHNICAL SUMMARY

THE OBJECTIVES IS TO IDENTIFY, DEVELOP, AND EVALUATE ADVANCED SIGNAL PROCESSING TECHNIQUES FOR COMMUNICATION SATELLITE SYSTEMS.

TECHNIQUES TO BE INVESTIGATED ARE MULTIPLE ACCESS, MODULATION, AND MULTIPLEXING TECHNIQUES. PARAMETRIC STUDIES WILL BE CONDUCTED TO IDENTIFY THOSE TECHNIQUES MOST APPLICABLE TO SPECIFIC CLASSES OF USERS. THESE STUDIES WILL ESTABLISH THE BASIS AND PRIORITIES FOR THE DEVELOPMENT AND EVALUATION OF HARDWARE. BY ASSURING THE AVAILABILITY OF REQUISITE TECHNIQUES AND HARDWARE, THE APPLICATION OF SPACE SYSTEMS TO THE SOLUTION OF A MULTITUDE OF PROBLEMS WILL BE ENHANCED

RTOP NO. 164-06-53 TITLE: BIOMEDICAL COMMUNICATIONS NETWORK

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: GUBIN, S. TEL. 301-982-2665

TECHNICAL SUMMARY

INVESTIGATE THE APPLICATIONS OF COMMUNICATIONS SATELLITES TO PROVIDE FOR THE TELECOMMUNICATIONS NEEDS OF THE BIOMEDICAL COMMUNITY.

THESE NEEDS INCLUDE THE INTERCHANGE OF DATA FROM A VARIETY OF USERS, INCLUDING: CENTRALIZED BIOMEDICAL CENTERS, MEDICAL SCHOOLS AND LIBRARIES, DIAGNOSTIC CENTERS, LARGE AND SMALL HOSPITALS, FIELD (MOBILE AND FIXED) MEDICAL FACILITIES, AND EVEN DOCTOR'S OFFICES. THE STUDY HAS SEVERAL PHASES AS FOLLOWS: (1) DETERMINE INFORMATION TRANSFER REQUIREMENTS; NETWORK DESCRIPTION, USER STATISTICS, (NODAL) POINT SPECIFICATIONS, ROUTING, TRAFFIC-LOADING TIME PROFILES, VIDEO VS DATA VS DATA-LINK VS VOICE, SIGNAL SPECIFICATION, RELIABILITY REQUIREMENTS, INPUT/OUTPUT DEVICE CHARACTERISTICS, COMPUTER USAGE INCLUDING DATA STORAGE, TIME SHARING, AND LOCATION, (2) CATALOGUE PROPAGATION PHENOMENA, DEVICE STATUS, ANTENNA TYPES, SENSORS AND DISPLAYS, DATA STORAGE AND RETRIEVAL SYSTEMS, (3) DESIGN CONCEPTUAL SATELLITE SYSTEMS AND TRADE-OFF COSTS WITH COMMON-CARRIER, DEDICATED-MICROWAVE AND CATV TYPE OF DISTRIBUTION SYSTEMS, (4) ESTABLISH SATELLITE COST EFFECTIVENESS, IDENTIFY NEEDED TECHNOLOGY AND EXPERIMENTS. THESE STUDIES WILL BE CONDUCTED IN CLOSE COOPERATION WITH HEW TO TAKE ADVANTAGE OF THEIR EXPERIENCE AND TO ASSURE THAT THEIR USER REQUIREMENT MODELS ARE PROPERLY FACTORED INTO THE STUDIES.

RTOP NO. 164-06-54 TITLE: USER REQUIREMENTS ANALYSES FOR DOMESTIC COMMUNICATIONS SATELLITE SYSTEMS

ORGANIZATION: NASA HEADQUARTERS

MONITOR: SILVERMAN, D. TEL. 202-963-7346

TECHNICAL SUMMARY

TO DETERMINE AND EVALUATE THE USER'S COMMUNICATIONS REQUIREMENTS FOR PLANNED AND FUTURE DOMESTIC COMMUNICATIONS SATELLITE SYSTEMS. TO PROVIDE CURRENT, UPDATED PROJECTIONS OF USER REQUIREMENTS FOR 1975-1990 WHICH ARE NEEDED TO ESTABLISH SYSTEM REQUIREMENTS AND IDENTIFY CRITICAL TECHNOLOGY. USER COMMUNICATION REQUIREMENTS FOR BIOMEDICAL COMMUNICATIONS NETWORK, TRACKING AND DATA RELAY, AND NAVIGATION/TRAFFIC CONTROL SYSTEMS WILL BE DEVELOPED JOINTLY BY THE COGNIZANT HEADQUARTERS PROGRAM CHIEF AND THE USER OFFICE OR AGENCY (DHEW, OTDA, FAA) FROM A "SUBSCRIBER-DESIRES" DATA BASE WHICH THE USER OFFICE OR AGENCY IS RESPONSIBLE FOR DEVELOPING. MILLIMETER WAVE COMMUNICATIONS SYSTEMS REQUIREMENTS WILL BE DEVELOPED BY GSFC, CODE

730, UNDER RTOP 164-06-50-05-1. INFORMATION NETWORK USER REQUIREMENTS WILL BE DEVELOPED BY CONTRACTORS UNDER THE DIRECTION OF HEADQUARTERS PROGRAM OFFICE CODE SC.

RTOP NO. 164-18-51 TITLE: NAVIGATION AND TRAFFIC CONTROL
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: MALINOWSKI, A. B. TEL. 301-982-5774
TECHNICAL SUMMARY

THE WORK IS DIRECTED TOWARD IMPROVING AND AUGMENTING THE PRESENT SYSTEMS RESPONSIBLE FOR TRAFFIC CONTROL SERVICES IN THE AREA OF SURVEILLANCE, NAVIGATION, COMMUNICATIONS, SEARCH AND RESCUE, AND COLLISION AVOIDANCE. THE WORK IS DIVIDED INTO AND DIRECTED TOWARDS TWO MAIN PROBLEMS (1) OCEANIC AREA SYSTEMS WHERE SURVEILLANCE NAVIGATION AND COMMUNICATIONS ARE KEY REQUIREMENTS AND (2) LAND MASS SYSTEMS WHERE SURVEILLANCE IS THE KEY REQUIREMENTS. THE WORK TOWARDS SOLUTION OF THESE PROBLEMS CONSISTS OF STUDY EFFORTS TO (1) DEVELOP NEW SATELLITE NAVIGATION AND SURVEILLANCE TECHNIQUES, (2) APPLY EXISTING SATELLITE NAVIGATION AND SURVEILLANCE TECHNIQUES, (3) DEVELOP NEW AND IMPROVED SATELLITE COMPONENTS, (4) DEVELOP COMMUNICATION TECHNIQUES FOR NAVIGATION/SURVEILLANCE/COMMUNICATION SYSTEMS, AND (5) DEFINE NAVIGATION, SURVEILLANCE EXPERIMENTS FOR SATELLITES. THE STUDY EFFORT ON SEARCH AND RESCUE AND COLLISION AVOIDANCE SYSTEMS IS APPLICABLE TO BOTH THE OCEANIC AREA AND LAND MASS SYSTEMS; AND WILL BE CLOSELY ASSOCIATED TO THE STUDIES OF SURVEILLANCE TECHNIQUES FOR AIR TRAFFIC CONTROL.

RTOP NO. 164-18-51 TITLE: NAVIGATION AND TRAFFIC CONTROL
ORGANIZATION: NASA WALLOPS STATION
MONITOR: MCGOOGAN, J. T. TEL. 703-824-3411
TECHNICAL SUMMARY

THIS NAVIGATION AND TRAFFIC CONTROL PROGRAM WILL PROVIDE A LABORATORY TYPE ANALYSIS OF SEVERAL NEW NAVIGATIONAL CONCEPTS. IT IS PLANNED TO CONDUCT FIELD EXPERIMENTS TO EMPIRICALLY DEMONSTRATE THE VALUE OF THESE TECHNIQUES. THE STUDIES WILL INCLUDE RANGING SYSTEMS WITH VARIOUS SPATIAL DISTRIBUTIONS AND UTILIZING PHASE, ENVELOPE AND CORRELATION DETECTION SCHEMES IN THE TIME INTERVAL MEASUREMENT SYSTEMS. IT IS NOT THE PRIME PURPOSE OF THIS STUDY TO DEVELOP NEW HARDWARE BUT TO RECONFIGURE, STRATEGICALLY LOCATE AND PROPERLY APPLY EXISTING HARDWARE TO ENHANCE ITS USE FOR PRACTICAL NAVIGATION MISSIONS. SPECIAL EMPHASIS WILL BE GIVEN TO THE ROLE OF SATELLITES IN NAVIGATION AND IN PARTICULAR USE OF EXISTING COMMUNICATIONS SATELLITES.

RTOP NO. 164-18-51 TITLE: NAVIGATION AND TRAFFIC CONTROL
ORGANIZATION: NASA HEADQUARTERS
MONITOR: EHRLICH, E. TEL. 202-962-2375
TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS TO GENERATE THE DESIGN OF A CONTROL

CENTER WHICH IS TO FUNCTION IN CONJUNCTION WITH A SATELLITE SYSTEM FOR NORTH ATLANTIC AIR TRAFFIC CONTROL. THIS WORK IS THE PLANNED FOLLOW-ON TO, AND USES RESULTS OF A DESIGN STUDY FOR A NORTH ATLANTIC AIR TRAFFIC CONTROL SYSTEM WHICH WAS INITIATED IN FY 70 UNDER P. R. PS-0071.

RTOP NO. 164-18-52 TITLE: DATA COLLECTION
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: GOULD, W. TEL. 301-982-6462
TECHNICAL SUMMARY

THE OBJECTIVE IS TO INVESTIGATE AND DEVELOP THE TECHNOLOGY NEEDED FOR COLLECTING DATA FROM MANY (UP TO 100,000) SENSOR INSTRUMENTED FIXED AND MOBILE DATA COLLECTION PLATFORMS USING SATELLITES. IN ADDITION, TO DEVELOP COMPATIBLE POSITION LOCATION TECHNIQUES FOR MOBILE PLATFORMS. A SIGNIFICANT OBJECTIVE WILL BE TO DEVELOP EXPERIMENTAL SYSTEM HARDWARE IN SUPPORT OF THE FIXED AND MOBILE PLATFORM SYSTEM CONCEPTS WHICH CAN BE IMPLEMENTED ECONOMICALLY, EXPEDITIOUSLY, AND WHICH CAN EVOLVE INTO AN ULTIMATE WORLD-WIDE DATA COLLECTION SYSTEM.

RTOP NO. 164-21-52 TITLE: COMMUNICATIONS SATELLITE MICROWAVE POWER RESEARCH TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ALEXOVICH, R. E. TEL. 216-433-4000
TECHNICAL SUMMARY

OBJECTIVE: TO ADVANCE THE STATE-OF-THE-ART IN HIGH POWER SATELLITE COMMUNICATION COMPONENTS AND SUBSYSTEMS ABOVE 10 GHZ, PRIMARILY IN SUPPORT OF APPLICATIONS OF SPACE BROADCASTING, INFORMATION NETWORKING, AND TO MEET FUTURE REQUIREMENTS IN THE POST 1975 TIME PERIOD. TO ACHIEVE THESE OBJECTIVES, RESEARCH AND TECHNOLOGY DEVELOPMENT PROGRAMS ARE UNDERWAY ON MICROWAVE AMPLIFIERS, ANTENNAS, RF HARDWARE, AND GROUND RECEPTION TECHNIQUES FOR SPACE APPLICATIONS. STUDIES AND INVESTIGATIONS OF SPACE-EARTH PROPAGATION AND INTERFERENCE ARE ALSO UNDERWAY. APPROACHES TO SPACECRAFT UPLINK COMMUNICATIONS AND COMMAND ARE UNDER INVESTIGATION. SPECIFIC TECHNIQUES SUCH AS MULTISTAGE DEPRESSED BEAM COLLECTION FOR LINEAR AND CROSSED-FIELD AMPLIFIERS ARE AMONG PROMISING TECHNIQUES BEING INVESTIGATED. THIS PROGRAM COUPLES WITH OTHER IN-HOUSE AND CONTRACT WORK UNDER RTOP COMMUNICATIONS SATELLITE POWER RESEARCH AND TECHNOLOGY, 164-21-53 AND MULTIPLE NARROW BEAM SHAPED PATTERN ANTENNA TECHNOLOGY DEVELOPMENT, 164-21-54.

RTOP NO. 164-21-53 TITLE: COMMUNICATIONS SATELLITE POWER RESEARCH AND TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ALEXOVICH, R. E. TEL. 216-433-4000
TECHNICAL SUMMARY

TO ADVANCE THE STATE-OF-THE-ART IN HIGH POWER TECHNOLOGY

NECESSARY TO DEVELOP, CONDITION, AND CONTROL ELECTRICAL POWER IN THE RANGE OF ONE KW TO 30 KW, DERIVED FROM SOLAR CELL ARRAYS FOR HIGH POWER COMMUNICATION SATELLITE APPLICATIONS SUCH AS SPACE BROADCASTING, TRACKING AND DATA RELAY, AND INFORMATION NETWORKING. TO ACHIEVE THESE OBJECTIVES, RESEARCH AND TECHNOLOGY DEVELOPMENT PROGRAMS ARE UNDERWAY ON METHODS OF ELECTRICAL POWER TRANSFER THROUGH ROTATING JOINT, LONG-LIFE POWER CONDITIONING SYSTEMS CAPABLE OF SUPPLYING LOADS REQUIRING UP TO 25 KV OF ELECTRICAL POWER. IN ADDITION, STUDIES AND INVESTIGATIONS ARE BEING CONDUCTED ON SUPPORT SYSTEMS SUCH AS SOLAR ARRAY SYSTEMS, SPACECRAFT STRUCTURES, APPROACHES TO ATTITUDE CONTROL AND STATION KEEPING, AND EFFICIENT METHODS OF HEAT REJECTION. THIS PROGRAM COUPLES WITH RTOP'S FOR COMMUNICATIONS SATELLITE MICROWAVE POWER RESEARCH TECHNOLOGY, 164-21-52, AND MULTIPLE NARROW BEAM SHAPED PATTERN ANTENNA TECHNOLOGY DEVELOPMENT, 164-21-54.

RTOP NO. 164-21-54 TITLE: MULTIPLE NARROW BEAM SHAPED PATTERN
ANTENNA TECHNOLOGY DEVELOPMENT

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: LYNCH, T. TEL. 301-982-2665

TECHNICAL SUMMARY

ONE OF THE ESSENTIAL SUBSYSTEMS OF ADVANCED DOMESTIC COMMUNICATIONS SATELLITE SYSTEMS IS A SATELLITE ANTENNA CAPABLE OF MULTIPLE, NARROW-BEAM AND SHAPED-BEAM TRANSMISSION. DEVELOPMENT OF SUCH AN ANTENNA SYSTEM IS NEEDED SINCE THE STATE-OF-THE-ART IS RELATIVELY NEW IN THIS AREA. SUCH A SYSTEM MUST HAVE SHAPED BEAM PATTERNS WITH LOW SIDELOBES IN ORDER TO: MINIMIZE SPILL-OVER INTO AREAS NOT INTENDED FOR RECEPTION, MAKE MORE EFFICIENT USE OF RADIATED ENERGY, DIMINISH THE PROBLEM OF INTERFERENCE WITH TERRESTRIAL SYSTEMS AND NEARBY COUNTRIES, AND MAKE MORE EFFICIENT USE OF THE GEOSTATIONARY ORBIT AND THE SHARED FREQUENCY SPECTRUM. DIFFERENT APPROACHES WILL BE ANALYZED FOR MEETING THE ABOVE ANTENNA REQUIREMENTS. ONE APPROACH THAT WILL BE GIVEN PARTICULAR EMPHASIS IS THE APPROACH USED IN THE LES-7 ANTENNA DESIGN. OTHER POSSIBILITIES INCLUDE DIELECTRIC LENS SYSTEMS, MULTIPORTED ARRAYS SUCH AS THE BUTLER ARRAY, RETRODIRECTIVE ANTENNAS, ETC.

RTOP NO. 164-21-54 TITLE: COMMUNICATION SATELLITE ANTENNA RESEARCH
ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

THIS EFFORT DEVISES AND DEMONSTRATES ANTENNA SYSTEM DESIGNS FOR NASA'S COMMUNICATION, BROADCAST, AND DATA RELAY SATELLITES, SO AS TO PERMIT EFFICIENT OPERATION AT NEW AND HIGHER FREQUENCIES; TO REDUCE THE SIDELOBES FROM A SINGLE ANTENNA; TO CREATE MULTIPLE ANTENNA BEAMS; AND TO ALLOW TRANSMISSIONS OF HIGHER POWER LEVELS. OPERATION AT HIGHER FREQUENCIES IS A NECESSITY IN AN ALREADY CROWDED SPECTRUM; THEREFORE, DURING FY'71, EMPHASIS WILL BE PLACED ON K-BAND OPERATION.

REDUCING SIDELOBE SPILLOVER WILL ALLOW MORE SATELLITES BY REDUCING MUTUAL INTERFERENCE BETWEEN SATELLITES. MULTIPLE AND STEERABLE BEAMS

ARE NECESSARY TO ALLOW TRANSMISSION TO DIFFERENT GROUND STATIONS FROM THE SAME SATELLITE, WITHOUT USING UP SPECTRUM SPACE AT EARTH LOCATIONS WHICH DO NOT REQUIRE TRANSMISSION. HIGHER POWER OPERATION IS NECESSARY IN SUCH APPLICATIONS SUCH AS POINT-TO-POINT HEAVY-DUTY TRUNKING, DIRECT TV BROADCAST TO REMOTE AREAS, AND DATA-DUMP INFORMATION TRANSFER. AN IN-HOUSE EFFORT IS PLANNED, WITH BOTH THEORETICAL AND EXPERIMENTAL EFFORTS. THE JPL/NASA MESA ANTENNA TEST RANGE WILL BE USED FOR PRECISION ANTENNA PATTERN MEASUREMENTS. THE RANGE WILL BE EQUIPPED WITH A K-BAND CAPABILITY FOR THIS PURPOSE. THE VOLTAGE BREAKDOWN FACILITY AT JPL WILL BE USED TO STUDY SUCH BREAKDOWN IN HIGH POWER ANTENNA DESIGNS. THIS WORK WILL BE COORDINATED WITH K-BAND RECEIVER WORK FOR THE MANNED SPACE STATION UNDER RTOP 125-21-16, SINCE THE SPACE STATION WILL BE A HEAVY USER OF THE TRACKING DATA RELAY SATELLITE AT K-BAND. THIS EFFORT WILL BE COORDINATED WITH RELATED WORK AT GODDARD SPACE FLIGHT CENTER.

RTOP NO. 164-21-54 TITLE: MULTIPLE NARROW BEAM SHAPED PATTERN
ANTENNA TECHNOLOGY DEVELOPMENT

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: ALEXOVICH, R. E. TEL. 216-433-4000

TECHNICAL SUMMARY

OBJECTIVE: TO ADVANCE THE STATE-OF-THE-ART IN MULTIPLE NARROW SHAPED BEAM ANTENNAS CAPABLE OF BEING SELECTIVELY STEERED TO ANY GEOGRAPHICAL AREA FOR COVERAGE WITHIN VIEW OF A GEOSTATIONARY SATELLITE OR FOR TRACKING AND/OR COMMUNICATION WITH LOW ORBITAL MISSION SPACECRAFT. INFORMATION NETWORKING SATELLITES, BROADCAST SATELLITES, SATELLITE-TO-SATELLITE COMMUNICATIONS, REUSABLE LAUNCH VEHICLE COMMUNICATIONS, AND DEEP SPACE COMMUNICATIONS. SURVEY LITERATURE AND ANALYTICALLY COMPARE VARIOUS APPROACHES. INITIATE DEVELOPMENT OF ANTENNA CONCEPTS WHICH OFFER A HIGH POTENTIAL FOR MEETING FUTURE MISSION OBJECTIVES. DETERMINE THE IMPACT OF NEWER METHODS OF SATELLITE LAUNCH UPON ANTENNA CONCEPTS. PROVIDE ESTIMATED COSTS AND SCHEDULES FOR THE DEVELOPMENT OF ANTENNAS FOR APPLICATION TO HIGH POWER COMMUNICATION SATELLITES.

RTOP NO. 164-21-55 TITLE: TRACKING DATA RELAY SATELLITE NETWORK
COMMUNICATIONS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

TRACKING AND DATA RELAY SATELLITES HAVE SIGNIFICANT POTENTIAL FOR IMPROVING THE COST-EFFECTIVENESS OF NEAR EARTH TRACKING AND DATA ACQUISITION. BEFORE SUCH SATELLITES ARE FULLY POSSIBLE, SIGNIFICANT IMPROVEMENTS IN COMMUNICATION TECHNOLOGY IN THE AREAS OF MULTIPATH AND INTERFERENCE IMMUNITY, ACQUISITION RELIABILITY, MODULATION, DETECTION, AND SIGNAL PARAMETER TOLERANCES ARE REQUIRED. THE LONG TERM OBJECTIVE IS TO DEVELOP COMMUNICATION TECHNOLOGY FOR THE TRACKING DATA RELAY SATELLITE NETWORK (TDRSN). EMPHASIS WILL BE PLACED ON COST-EFFECTIVE SYSTEM DESIGNS. THE SPECIFIC OBJECTIVES INCLUDE DEVELOPING FUNCTIONAL SPECIFICATIONS, MULTIPATH PROPAGATION

MODEL SIMULATION, SYSTEM FUNCTIONAL PERFORMANCE DEMONSTRATION, AND DEMONSTRATING MULTIPLE USER FEASIBILITY. DETECTION TECHNIQUES EFFECTIVE AGAINST MULTIPATH AND DOPPLER WILL BE DEVELOPED. REQUIREMENTS FOR PLANETARY TRACKING DATA RELAY SATELLITES WILL BE ESTIMATED. THE OBJECTIVES WILL BE ACHIEVED BY ANALYSIS AND DESIGN ACTIVITIES THAT ARE SUPPORTED BY EXPERIMENT AND SIMULATION. SOME CONTRACTED ASSISTANCE WILL BE REQUIRED IN THE EXPERIMENTAL EFFORT. THE TECHNICAL APPROACH WILL BE TO BUILD ON AND EXTEND THE FY 70 ACCOMPLISHMENTS FROM BOTH THE 164-21 AND 125-21-09 EFFORTS AT JPL. THIS WORK WILL BE COORDINATED WITH MICROWAVE RESEARCH FOR THE SPACE STATION UNDER RTOPS 125-21-16 AND 125-21-18, SINCE THE MANNED SPACE STATION WILL BE A HEAVY USER OF THE TDRSN.

RTOP NO. 164-21-55 TITLE: TRACKING AND DATA RELAY SATELLITE
TECHNOLOGY DEVELOPMENT

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: HABIB, E. J. TEL. 301-982-4776

TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE FOR AN ORDERLY DEVELOPMENT OF THE COMMUNICATION TECHNIQUES REQUIRED FOR IMPLEMENTING A TRACKING AND DATA RELAY SYSTEM FOR SUPPORT OF NASA MISSIONS IN THE MID-1970'S AND BEYOND. VARIOUS STUDIES SHALL BE PERFORMED TO IDENTIFY THE PROBLEMS ASSOCIATED WITH SUCH A SYSTEM. THE IDENTIFIED PROBLEMS WILL THEN BE ATTACKED IN A UNIFIED MANNER. TRADEOFF AREAS WILL BE IDENTIFIED AND BOTH DATA AND CRITERIA WILL BE DEVELOPED TO AID IN CHOICE OF THE TRADEOFF. THE STATE OF THE ART WILL BE DETERMINED AND WHERE NECESSARY TECHNOLOGY DEVELOPMENT PROGRAMS WILL BE INITIATED. THE TDRS INVOLVES THE USE OF HIGHLY STABLE AND COMPLEX SATELLITES AT SYNCHRONOUS ALTITUDES WITH MULTIPLE, INDIVIDUALLY POINTABLE, ANTENNA BEAMS. THEREFORE A CONSIDERABLE AMOUNT OF EFFORT WILL BE SPENT ON THE DEVELOPMENT OF UNIQUE SPACECRAFT TECHNOLOGY.

RTOP NO. 164-21-56 TITLE: COMMUNICATIONS TECHNOLOGY SUPPORT STUDIES

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: CRAFT, H. G. TEL. 205-453-3425

TECHNICAL SUMMARY

THIS RTOP COVERS INVESTIGATIONS OF BASIC PROBLEMS RELATING TO THE DESIGN OF TV BROADCAST SATELLITES. IT COVERS THE DEFINITION OF PARAMETERS AND THE DEVELOPMENT AND APPLICATION OF MODELS FOR SYSTEM OPTIMIZATION AS WELL AS THE INVESTIGATION OF PROBLEM AREAS IN TRANSMITTER DESIGN. INVESTIGATIONS IN THESE AREAS ARE ESSENTIAL TO PERMIT THE SELECTION OF OPTIMUM SYSTEM DESIGNS FOR VARIOUS APPLICATIONS.

RTOP NO. 164-21-71 TITLE: RADIO-FREQUENCY INTERFERENCE AND
PROPAGATION PROGRAM (RIPP)

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: ECKERMAN, J. TEL. 301-982-2180

TECHNICAL SUMMARY

COMMUNICATIONS IS IN THE MIDST OF AN UNPRECEDENTED, INTENSE COMPETITION FOR SPECTRUM SPACE FROM A HOST OF NEW APPLICATIONS. THESE APPLICATIONS AND RESULTING COMPETITION ARISE FROM THE PRESENT AND FUTURE AVAILABILITY OF SPACE TECHNOLOGY. WHETHER ACTUAL OR POTENTIAL, THE LIST OF APPLICATIONS IS LARGE AND CONTINUES TO GROW. FOR SOME APPLICATIONS, SATELLITES MAY DISPLACE TERRESTRIAL INSTALLATIONS. IN OTHERS, NEW SERVICES WILL BE ESTABLISHED; IN STILL OTHERS, COMPETITIVE SERVICES WILL ARISE. WHILE ATTENTION IS PAID IN EACH CASE TO OPTIMIZING ITS OWN SYSTEM, EFFORTS TOWARDS OPTIMIZING THE OVERALL USE OF SPECTRAL AND ORBITAL SPACE HAVE, THUS FAR, BEEN SPORADIC. IT IS PARTICULARLY IMPORTANT, THEN, TO EXAMINE CAREFULLY BOTH THE THEORETICAL AND EXPERIMENTAL FOUNDATIONS OF FUTURE SPACE APPLICATIONS AND THEIR CORRESPONDING FREQUENCY AND ORBIT ALLOCATION PROPOSALS. WITH THIS AS A GOAL, THE RADIO-FREQUENCY INTERFERENCE AND PROPAGATION PROGRAM (RIPP) WAS ESTABLISHED. THIS PROGRAM IS AIMED SPECIFICALLY AT DETERMINING: 1. WHETHER COMMUNICATIONS SATELLITE SYSTEMS AND TERRESTRIAL SYSTEMS CAN CONTINUE TO SHARE THE SAME FREQUENCIES BANDS AS THE NUMBERS OF BOTH SYSTEMS INCREASE. 2. THE CONDITIONS FOR SHARING SUCH AS REQUIRED GEOGRAPHICAL SEPARATION, EARTH STATIONS AND SPACECRAFT RECEIVER AND TRANSMITTER CHARACTERISTICS, ETC. 3. THE INFLUENCE OF WEATHER ON INTER-SYSTEM INTERFERENCE. 4. THE UTILITY OF FREQUENCIES ABOVE 10 GHZ FOR COMMUNICATIONS SATELLITE SERVICES.

RTOP NO. 164-21-72 TITLE: COOPERATIVE APPLICATION SATELLITE - C

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: ALEXOVICH, R. E. TEL. 216-433-4000

TECHNICAL SUMMARY

TO ADVANCE THE STATE-OF-THE-ART IN SPACECRAFT AND RELATED GROUND-BASED TECHNOLOGIES RELEVANT TO FUTURE COMMUNICATIONS AND OTHER SATELLITE APPLICATIONS SYSTEMS BE MEANS OF A JOINT NASA/CANADIAN APPLICATION TECHNOLOGY SATELLITE. A COOPERATIVE APPLICATION SATELLITE WILL BE ANALYZED, DESIGNED, FABRICATED, LAUNCHED AND TESTED WHICH SHALL DEMONSTRATE THE FOLLOWING. NASA, AND IN PARTICULAR LERC, WILL BE RESPONSIBLE FOR SYSTEMS QUALIFICATION, LAUNCH VEHICLE INTEGRATION, AND THE TUBE OF (1) BELOW. ALL OTHER ASPECTS SHALL BE THE RESPONSIBILITY OF CANADA. 1. A SUPER-EFFICIENCY 12 GHZ TUBE OF A POWER OF 200 W OR ABOVE WITH SUPPORTING SUBSYSTEMS; 2. A HIGH POWER, LIGHTWEIGHT SOLAR ARRAY; 3. POWER TRANSFER BY MEANS OF LIQUID METAL SLIP RINGS; 4. STATION KEEPING BY MEANS OF ELECTRICAL PROPULSION; 5. COMMUNICATION EXPERIMENTS AT 12 GHZ AND UHF. THE LAUNCH DATE WILL BE IN THE MID 1970'S. THE RESPONSIBILITIES FOR VARIOUS EXPERIMENTS AND SUBSYSTEMS SHALL BE NEGOTIATED.

RTOP NO. 164-21-73 TITLE: TECHNICAL CONSULTATION PROGRAMS (TCP)
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: ECKERMAN, J. TEL. 301-982-2180
TECHNICAL SUMMARY

THE WORK TO BE PERFORMED INVOLVES TECHNICAL CONSULTATION AND SUPPORT ON SPACE COMMUNICATIONS MATTERS TO NASA/HQ, FCC, OTP, COMSAT.

RTOP NO. 164-43-51 TITLE: GEODESY & GEODETIC SYSTEMS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: BERBERT, J. H. TEL. 301-982-5055
TECHNICAL SUMMARY

PROGRAM CONDUCTS STUDIES AND DEVELOPS TECHNOLOGY OF GEODETIC TRACKING SYSTEMS AND OPERATIONAL AND ANALYSIS TECHNIQUES FOR UTILIZING SPACECRAFT TRACKING DATA FOR GEODESY. EXPECTED RESULTS INCLUDE THE DETERMINATION OF THE MOST SUITABLE GRAVITY MODELS FOR GODDARD TRAJECTORIES NEAR THE EARTH, MOON, AND PLANETS, AND A MORE ACCURATE DETERMINATION OF THE COORDINATES OF THE NASA TRACKING STATIONS ON A UNIFIED WORLD DATUM. THESE RESULTS SHOULD IMPROVE NASA'S ORBIT PREDICTION AND MISSION ANALYSIS CAPABILITIES LEADING TO A POSSIBLE REDUCTION IN TRACKING DATA COLLECTION AND ANALYSIS REQUIREMENTS. NEW GRAVITY FIELDS AND STATION COORDINATES ARE COMPARED WITH PREVIOUS SOLUTIONS TO ASCERTAIN THEIR ADEQUACY FOR NASA MISSIONS. NEW TECHNIQUES AND DATA TYPES SUCH AS SATELLITE-TO-SATELLITE TRACKING ARE INVESTIGATED TO DETERMINE THEIR POTENTIAL CONTRIBUTION TO GEODETIC APPLICATIONS.

RTOP NO. 164-43-54 TITLE: APPLICATIONS OF GEODETIC SATELLITES TO
MARINE GEODESY AND ALTIMETRY
ORGANIZATION: WALLOPS STATION
MONITOR: SELSER, A. R. TEL. 703-824-3411
TECHNICAL SUMMARY

THE PURPOSE OF THIS PROJECT IS TO EVALUATE THE PROPER UTILIZATION OF HARDWARE AND SOFTWARE GEODETIC SATELLITE TECHNIQUES AND TECHNOLOGY IN MARINE GEODESY AND SATELLITE ALTIMETRY APPLICATIONS. IN THE FIELD OF MARINE GEODESY AND MARINE GRAVIMETRY, THERE EXISTS STRONG INDICATION THAT CURRENT SHIP AND LAND BASED TRACKING INSTRUMENTATION HAS THE POTENTIAL FOR PROVIDING BROAD OCEAN POSITIONING TO AN ACCURACY OF 10 METERS OR BETTER. THESE ACCURACIES WILL BE OF MAJOR VALUE IN SETTING OUT AND MAINTAINING NETWORKS OF SURFACE AND BOTTOM REFERENCE SOURCES. THEY WILL ALSO GREATLY IMPROVE MARINE GRAVIMETRY BY PROVIDING REFERENCING OF THE SURFACE GRAVITY POINTS TO A COMMON EARTH CENTERED DATUM. THE USE OF SATELLITE ALTIMETRY FOR OCEAN SURFACE MAPPING WILL BE AN ADVANCE IN THE STATE-OF-THE-ART OF MARINE GRAVIMETRY, AREAS OF SPARSE MARINE GRAVITY MEASUREMENTS CAN BE FILLED IN RAPIDLY AND COMPLETE GLOBAL GRAVITY MAPS UTILIZING MARINE GRAVIMETRY, LAND GRAVIMETRY, AND SATELLITE ALTIMETRY CAN BE PREPARED. SEVERAL METHODS HAVE BEEN DEVELOPED BY GOVERNMENT, INDUSTRY, AND THE ACADEMIC COMMUNITY FOR COMBINING THESE MEASUREMENTS. BEFORE THE FULL POTENTIAL CAN BE REACHED HOWEVER, EVALUATION OF THE TECHNIQUES AND HARDWARE USED TO OBTAIN THE BASIC

MEASUREMENTS MUST BE PERFORMED. THE INITIAL EMPHASIS IN THIS RTOP IS AN EVALUATION STUDY OF THE BASIC MEASURING SYSTEMS, HOW THEY CAN BEST BE COMBINED TO PROVIDE POSITIONING AND ALTIMETRY DATA, HOW WELL THE SYSTEMS CAN BE CALIBRATED, WHAT THE MOST SIGNIFICANT ERROR CONTRIBUTIONS ARE, AND WHAT DEVELOPMENT AREAS NEED TO BE STRESSED FOR MEETING PROGRESSIVELY STRINGENT REQUIREMENTS.

RTOP NO. 164-76-51 TITLE: SYNCHRONOUS ORBIT SPACECRAFT TECHNOLOGY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: HOFFMAN, H. C. TEL. 301-982-4496
TECHNICAL SUMMARY

THIS PROJECT WILL DEVELOP LONG LEAD TIME SPACECRAFT SYSTEM TECHNOLOGY, OF SPECIFIC APPLICABILITY TO SYNCHRONOUS EQUATORIAL MISSIONS, PLANNED FOR THE LATE 1970'S AND EARLY 1980'S. THE RESULTS COULD BE APPLICABLE TO MISSIONS SUCH AS ATS-H AND ATS-J TRACKING AND DATA RELAY SATELLITE AND TV DISTRIBUTION/DIRECT BROADCAST SATELLITES.

THE EFFORTS WILL BE TOWARD BOTH HIGH ACCURACY POINTING SYSTEMS (.001 DEGREES) AND TOWARDS A DEEPER UNDERSTANDING OF PASSIVE SYSTEMS. STUDIES WILL BE CARRIED OUT ON SYNCHRONOUS ALTITUDE SYSTEM DESIGN CONCEPTS, PRECISION MEASUREMENT SYSTEMS, ADVANCED DYNAMIC ANALYSES OF SPACECRAFT FLEXIBILITY, AND ADVANCED THRUSTERS AND TORQUERS FOR PRECISE EARTH ORIENTED SPACECRAFT.

RTOP NO. 164-76-52 TITLE: SYNCHRONOUS ORBIT KICK MOTOR TECHNOLOGY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE ATS APOGEE MOTOR DESIGN WAS REVIEWED TO DETERMINE THOSE COMPONENT AREAS WHERE PERFORMANCE CAN BE INCREASED AND THE TOTAL MOTOR OPTIMIZED BY THE INCORPORATION OF ADVANCED SOLID ROCKET MATERIALS AND PROCESSES. COMPOSITE FILAMENT MATERIALS WERE EVALUATED FOR USE IN FABRICATING SOLID PROPELLANT ROCKET MOTOR CASES. THE OPTIMIZED ATS APOGEE MOTOR WILL BE USED AS A BASELINE WITH PROPELLANT OFF-LOADING FOR GEOSTATIONARY MISSIONS ON THE SIX SOLID AND NINE SOLID IMPROVED THOR DELTA VEHICLE. EXTENSIVE TESTING OF ROCKET MOTOR CHAMBERS FABRICATED FROM A BORON COMPOSITE MATERIAL WILL VERIFY THE STRUCTURAL DESIGN PARAMETERS PREVIOUSLY DETERMINED. TESTING OF THE CHAMBERS WILL BE ACCOMPLISHED BY THE JPL CULMINATING IN A LIVE MOTOR FIRING. THREE BORON COMPOSITE ROCKET MOTOR CHAMBERS HAVE BEEN RECEIVED AND ARE READY FOR THE REQUIRED DEVELOPMENT TESTS. BASED ON THE RESULTS OF THE BORON COMPOSITE TESTS AND THE COMPUTER ANALYSIS PROGRAM, THE GREATER POTENTIAL OF THE GRAPHITE FILAMENT REINFORCED COMPOSITE WILL BE INVESTIGATED. THIS WILL BE ACCOMPLISHED IN A SIMILAR MANNER USED FOR THE BORON FILAMENT PROGRAM. THAT IS GRAPHITE FILAMENT EPOXY SPECIMENS WILL BE FABRICATED AND TESTED WITH THE RESULTS BEING UTILIZED IN THE COMPUTER ANALYSIS PROGRAM. FROM THIS INVESTIGATION A GRAPHITE FILAMENT REINFORCED COMPOSITE CASE WILL BE DESIGNED.

RTOP NO. 164-76-53 TITLE: APPLICATIONS MISSION THRUSTER STUDIES
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, ROBERT V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS TO CONDUCT THRUSTER TRADEOFF STUDIES DIRECTED TOWARD CHARACTERIZING THRUSTER BEHAVIOR APPLIED TO SPACECRAFT ATTITUDE AND PERIOD CONTROL, AND TO DEVELOP FIGURES-OF-MERIT FOR OPTIMAL THRUSTER APPLICATIONS FOR USE BY PROGRAM PLANNERS. THE TECHNIQUES AND INFORMATION GENERATED DURING FY'70 UNDER CODE 164-76-01-03-55 WILL BE EXTENDED TO INCLUDE THE EVALUATION OF ELECTRIC PROPULSION SYSTEMS FOR SATELLITES. FIGURE-OF-MERIT DEVELOPMENT WILL BE EXTENDED FROM THE COST-EFFECTIVENESS BASIS DEVELOPED IN FY'70 TO A MORE FLEXIBLE, MISSION ORIENTED BASIS. RESULTS WILL BE PUBLISHED IN AN ADDENDUM TO THE REPORT "SATELLITE AUXILLIARY-PROPULSION SELECTION TECHNIQUES" GENERATED IN FY 1970.

RTOP NO. 164-76-54 TITLE: ATS-5 DESPIN MISSION
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: PHENIX, J. E. TEL. 301-982-4468
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS STUDY PROGRAM IS TO INVESTIGATE FEASIBILITY AND DEFINE THE TECHNOLOGY FOR A REMOTELY CONTROLLED MANEUVERABLE SPACECRAFT CAPABLE OF RENDEZVOUS AND DOCKING AT SYNCHRONOUS ALTITUDE. AN APPLICATION OF THIS CAPABILITY IS THE DESPINING OF ATS-5. OTHER APPLICATIONS INCLUDE OBSERVATION OF ATS-5 GRAVITY GRADIENT BOOM DEPLOYMENT AND ATS-F DISH ANTENNA DEPLOYMENT. THE APPROACH WILL EMPHASIZE THE EMPLOYMENT AND INTEGRATION OF EXISTING TECHNOLOGY AND HARDWARE IN ORDER TO EFFECT AN EXPEDIENT AND ECONOMICAL SPACECRAFT DESIGN.

RTOP NO. 164-90-51 TITLE: COMMUNICATIONS SR&T
ORGANIZATION: NASA HEADQUARTERS
MONITOR: JENKEL, A. A. TEL. 202-962-2110
TECHNICAL SUMMARY

RESEARCH AND STUDIES OF AN INTERDISCIPLINARY NATURE WILL BE CONDUCTED. SUPPORT WILL CONTINUE TO BE PROVIDED IN THE AREAS OF POST DOCTORAL FELLOWSHIPS AND SCIENCE/ENGINEERING GRADUATE FELLOWSHIPS FOR COMMUNICATIONS' AREA RESEARCH; THE INDIVIDUALS SELECTED WOULD CONTINUE TO WORK PROBABLY AT GSFC. CONTRACT ADMINISTRATION BY THE AIR FORCE AUDITING TEAMS WILL CONTINUE TO BE SUPPORTED. THE AIR FORCE AUDITS NASA CONTRACTS IN ADDITION TO THEIR OWN. SPECIAL REPORTS, STUDIES, AND REQUIREMENTS ARE NEEDED FROM TIME TO TIME TO SATISFY PROGRAMMATIC NEEDS; THESE WILL BE PURSUED. IN ADDITION, INTERDISCIPLINARY SUPPORT FOR GSFC WILL CONTINUE.

RTOP NO. 180-03-50 TITLE: PRESSURE VESSEL MATERIAL RESEARCH
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: DRALEY, E. C. TEL. 703-827-3285
TECHNICAL SUMMARY

VARIOUS SPECIMENS OF IRON ALLOYS WILL BE EXPOSED TO SULFUR HEXAFLUORIDE AT TEMPERATURES UP TO 450 DEGREES F. AND PRESSURES UP TO 1,000 PSI. THESE SPECIMENS WILL THEN BE SPECTROGRAPHICALLY ANALYZED TO DETERMINE THE CHEMICAL COMPOUNDS FORMED AND TESTED TO DETERMINE ANY DEGRADATION IN THE MECHANICAL PROPERTIES.

RTOP NO. 180-06-50 TITLE: ANALYSIS OF LAUNCH VEHICLE REQUIREMENTS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ZIMMERMAN, A. V. TEL. 216-433-4000
TECHNICAL SUMMARY

PERFORMANCE, TRAJECTORY, AND PAYLOAD CHARACTERISTICS OF LAUNCH VEHICLE SYSTEMS WILL BE INVESTIGATED TO EVALUATE THE CAPABILITY OF EFFICIENTLY PERFORMING THE PRESENT AND PLANNED SPECTRUM OF AUTOMATED MISSIONS.

RTOP NO. 180-06-50 TITLE: ANALYSIS OF ADVANCED PROPULSION SYSTEMS REQUIREMENTS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: SQUIRES, R. K. TEL. 301-982-4446
TECHNICAL SUMMARY

A CONTINUING PROGRAM HAS BEEN UNDERWAY FOR SEVERAL YEARS AIMED AT EVALUATING AND ANALYZING THE CAPABILITY OF EXISTING AND PROPOSED PROPULSIVE SYSTEMS FOR ACCOMPLISHING PLANNED OR PROPOSED AUTOMATED MISSIONS. THE THEORY, ANALYTICAL APPROACHES AND COMPUTER IMPLEMENTATION OF THE TASK NECESSARY TO CONDUCT THIS WORK HAVE BEEN PURSUED AT PRINCETON UNIVERSITY, AEROSPACE SYSTEMS LAB. CURRENT EFFORTS ARE DIRECTED AT EXTENDING THE CAPABILITIES OF THESE TOOLS AS WELL AS THE USE OF THE TOOLS ALREADY DEVELOPED TOWARD THE GENERATION OF MISSION DATA FOR A BROAD RANGE OF MISSIONS AND UPDATING NASA'S LAUNCH VEHICLES ESTIMATING FACTORS BOOKLET FOR SOLAR ELECTRIC PROPULSION. COMPARISONS ARE BEING MADE BETWEEN HIGH AND LOW THRUST MISSIONS TO ESTABLISH WHICH IS THE PREFERRED SYSTEM.

RTOP NO. 180-06-51 TITLE: MISSION REQUIREMENTS FOR NUCLEAR ELECTRIC SPACECRAFT
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. J. TEL. 213-354-2546
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO INVESTIGATE THE DIRECT CONSEQUENCE OF UTILIZING NUCLEAR REACTOR POWER - ELECTRIC PROPULSION TO PROVIDE PRIME PROPULSION ABOARD PLANETARY SPACECRAFT WITH EMPHASIS ON DETERMINING UNIQUE MISSION FEATURES, PAYLOAD CAPABILITY, LAUNCH VEHICLE AND SPACECRAFT INTEGRATION PROBLEMS AND SOLUTIONS, GROUND SUPPORT AND PRELAUNCH TESTING REQUIREMENTS, RESTRICTIONS DUE TO RANGE

SAFETY, AND OVERALL MISSION COSTS. THIS TASK WILL SUPPLEMENT OVERALL SPACECRAFT DESIGN STUDIES PRESENTLY BEING CONDUCTED WHICH PRIMARILY EMPHASIZE THE PROPULSION SYSTEM ITSELF. THE PROGRAM WILL BE CONDUCTED PRIMARILY UNDER INDUSTRY STUDY CONTRACTS SUPPLEMENTED BY IN-HOUSE SUPPORT ANALYSES.

RTOP NO. 180-06-52 TITLE: LAUNCH VEHICLE CONCEPTS AND ANALYSIS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: DRALEY, E. C. TEL. 703-827-3285
TECHNICAL SUMMARY

THE FOLLOWING PROGRAMS WILL BE ACCOMPLISHED. A. TO DETERMINE THE FEASIBILITY OF USING A LAUNCH VEHICLE WITH A SPIN-STABILIZED FINAL STAGE TO ACHIEVE LUNAR ORBIT. AN INVESTIGATION WILL IDENTIFY ALLOWABLE TOLERANCES ON INJECTION ERRORS TO INSURE ENTRY INTO THE LUNAR SPHERE OF INFLUENCE, THE TRANSLUNAR TRAJECTORY WHICH IS LEAST SENSITIVE TO THESE ERRORS ON LUNAR ARRIVAL CONDITIONS AND BODY ATTITUDE DEVIATIONS IN THE VICINITY OF THE MOON. B. TO EXTEND THE SUCCESSFUL DESIGN PRINCIPLES, EXPERIENCE, AND OPERATIONS TECHNOLOGY OF THE SCOUT BOOSTER SYSTEM BY MODIFICATIONS WHICH WILL ENHANCE ITS CURRENT CAPABILITY AND COST EFFECTIVENESS. THE BROAD STUDY WILL EVALUATE CONFIGURATIONAL CHANGES IN TERMS OF PERFORMANCE, COST, AND SCHEDULED PHASE-IN WITH THE PRESENT SYSTEM. C. TO PROVIDE A TRAJECTORY ANALYSIS TOOL ENABLING A MORE RAPID AND REALISTIC DETERMINATION OF THE ACTUAL ROCKET MOTOR PERFORMANCE. ANY OFF-NOMINAL SYSTEM PERFORMANCE OR SYSTEM CONSTANTS WILL ALSO BE REVEALED. THIS WILL BE OF SPECIAL VALUE IN EVALUATING NEW CONFIGURATIONS.

RTOP NO. 180-06-53 TITLE: LAUNCH OPERATIONS WITH UPPER STAGES
CONTAINING FLUORINE
ORGANIZATION: JOHN F. KENNEDY SPACE CENTER
MONITOR: TRITTO, J. TEL. 305-853-9136
TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS TO IDENTIFY THE OPTIMUM CHANGES TO LAUNCH OPERATIONS PROCEDURES, PRECAUTIONS, EQUIPMENT, AND FACILITIES TO SUPPORT LAUNCH UPPER STAGES CONTAINING FROM 3 TO 15 THOUSAND POUNDS OF FLUORINE IN THE PROPELLANTS ON THE THRUST AUGMENTED THOR FROM COMPLEX 17 AND THE TITAN III-D/CENTAUR FROM COMPLEX 40; AND TO PROVIDE DETAILED ESTIMATES OF THE ONE TIME COSTS AND SCHEDULES TO MAKE THE CHANGES AND DETAILED ESTIMATES OF THE INCREASED RECURRING COSTS AND GROUND OPERATIONS TIME TO CONDUCT THE LAUNCHES.

RTOP NO. 180-06-60 TITLE: PLANNING RESEARCH IN THE AREA OF LAUNCH
VEHICLE AND PROPULSION PROGRAMS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: LAM, B. C. TEL. 202-962-4553
TECHNICAL SUMMARY

UNDER THIS PROCUREMENT, DOCUMENTS ARE ASSEMBLED AND MAINTAINED,

AND STUDIES ARE CONDUCTED TO AID NASA OSSA LAUNCH VEHICLE AND PROPULSION PROGRAMS DIVISION IN SATISFYING ITS RESPONSIBILITIES FOR PLANNING AND MAINTAINING AN ECONOMICAL AND RELIABLE SPACE TRANSPORTATION SYSTEM FOR FUTURE OSSA, OTHER NASA, OTHER U. S. GOVERNMENT, FOREIGN, AND COMMERCIAL DOMESTIC USERS. DOCUMENTS ARE MAINTAINED THAT PROVIDE DATA AND OTHER INFORMATION ON SPACE TRANSPORTATION SYSTEM PERFORMANCE, MISSION ANALYSIS, SPACE TRANSPORTATION SYSTEM RELIABILITY, AND SPACE TRANSPORTATION SYSTEM COSTS. STUDIES ARE PERFORMED TO: 1. DETERMINE THE LIKELY RANGE OF FUTURE REQUIREMENTS FOR LAUNCH VEHICLES; 2. EVALUATE NEW SPACE TRANSPORTATION SYSTEM CONCEPTS AND RELATED TECHNOLOGY; 3. ANALYZE PRESENT AND FUTURE SPACE TRANSPORTATION SYSTEM CAPABILITIES IN TERMS OF REQUIREMENTS; 4. CONTINUE TO IMPROVE AND APPLY METHODS FOR ESTIMATING FUTURE SPACE TRANSPORTATION SYSTEM COSTS; 5. ANALYZE THE EFFECT OF SPACE TRANSPORTATION SYSTEM COMPOSITION AND PROJECTED MISSION PLANS ON PROJECTED SPACE TRANSPORTATION SYSTEM COSTS; 6. PROVIDE ECONOMIC AS WELL AS TECHNICAL INFORMATION AND ANALYZES TO SERVE AS A BASIS FOR COMMUNICATING TECHNOLOGY NEEDS TO OART AND NASA CENTERS; AND 7. GENERATE TRAJECTORIES AND OTHER INFORMATION TO SUPPORT MISSION ANALYSES AND OTHER MISSION PLANNING ACTIVITIES AS REQUIRED.

RTOP NO. 180-06-60 TITLE: PAYLOAD EXPERIMENT PACKAGE (PEP)

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: HALTERMANN, R. TEL. 301-982-6113

TECHNICAL SUMMARY

THE SUCCESSFUL COMPLETION OF THE PASSIVE ATTITUDE CONTROL (PAC) PROGRAM 180-17-01, HAS LED TO THE SUBMISSION BY THE MCDONNELL DOUGLAS COMPANY OF A PAYLOAD EXPERIMENT PACKAGE FEASIBILITY STUDY. THE STUDY CONTAINS INITIAL DESIGNS, CONCLUDES THAT THE BASIC CONCEPT OF PEP IS TECHNICALLY SOUND, AND THAT FINAL DESIGN IS THE NEXT LOGICAL PHASE TOWARDS IMPLEMENTATION. INITIAL FUNDING OF THE FINAL DESIGN EFFORT HAS BEEN ACCOMPLISHED THROUGH TRANSFER OF LEFT-OVER PAC FUNDS.

RTOP NO. 180-11-51 TITLE: PREDICTION OF SPACECRAFT DYNAMIC
STRUCTURAL LOADS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MEEKS, P. TEL. 213-354-2546

TECHNICAL SUMMARY

THE ESTABLISHMENT OF STRUCTURAL DESIGN LOADS FOR A NEW SPACECRAFT IS A MATTER OF MUTUAL CONCERN TO SPACECRAFT MANAGEMENT AND LAUNCH VEHICLE MANAGEMENT. IT IS BECOMING GENERALLY RECOGNIZED THAT MORE THAN A "BLACK BOX" VIBRATION TEST SPECIFICATION IS REQUIRED FOR THE STRUCTURAL DESIGN OF THE SPACECRAFT. IN ADDITION TO SPACECRAFT NEEDS, ASSURANCE IS ALSO REQUIRED THAT THE STRUCTURE OF THE LAUNCH VEHICLE AND THE CHARACTERISTICS OF ITS FLIGHT CONTROL SYSTEM ARE COMPATIBLE WITH A NEW PAYLOAD. THE PRINCIPAL OBJECTIVE OF THIS TASK IS TO USE INFORMATION AVAILABLE FROM FLIGHT PROGRAM ACTIVITIES AND RELATED STUDIES AND SYNTHESIZE AN APPROACH DIRECTED TOWARD IMPROVING THE EARLY PREDICTION OF CRITICAL LOADINGS ON THE ENTIRE SPACE VEHICLE

DURING THE LAUNCH PHASE. INITIAL EMPHASIS WILL BE PLACED ON ANALYSIS OF EXISTING FLIGHT DATA. THROUGH COORDINATION AMONG LERC, GSFC, AND JPL, UNIQUE SETS OF ACCELERATION-TIME HISTORIES HAVE BEEN OBTAINED DURING FIVE LAUNCHES OF ATLAS/CENTAUR BOOSTED SPACECRAFT. THE DATA ARE UNIQUE BECAUSE THEY ARE PHASE-COHERENT AND PERMIT THE SYNTHESIS OF THE TIME HISTORIES OF THE SIX COMPONENTS OF RIGID BODY MOTION IN A PLANE OF THE SPACECRAFT/LAUNCH VEHICLE ADAPTER. THESE DATA, WITH APPROPRIATE THREE-DIMENSIONAL MATHEMATICAL MODELS OF THE SPACE VEHICLE, WILL BE ANALYZED AND A COMPARISON OF CALCULATED AND MEASURED FORCING FUNCTION WILL BE MADE. THE FORCING FUNCTION, IN TURN, CAN BE TREATED STATISTICALLY AND USED TO PREDICT THE LOADS THE LAUNCH VEHICLE IMPOSES ON A NEW SPACECRAFT. CONSIDERATION OF THE DATA AND ANALYSIS TECHNIQUE WILL ULTIMATELY LEAD TO A PROPOSAL FOR A DATA ACQUISITION PLAN WHICH INCLUDES THE FLIGHT INSTRUMENTATION, ANALYSIS TECHNIQUE, STATISTICAL TREATMENT AND APPLICATION TECHNIQUES. THE AVAILABLE DATA WERE ACQUIRED BY COOPERATIVE EFFORTS AMONG JPL, LERC AND GSFC.-----

RTOP NO. 180-17-50 TITLE: ASTRIONIC SYSTEMS EVALUATION

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: BECKHAM, J. M. TEL. 301-982-6356

TECHNICAL SUMMARY

DUE TO THE EFFECTS OF LINEAR AND ANGULAR VIBRATION ENVIRONMENTS ON GYROS AND ACCELEROMETERS, DEGRADATION OF THE PERFORMANCE OF THESE COMPONENTS WILL RESULT. IN ADDITION, THE TOTAL SYSTEM MAY EXPERIENCE DYNAMIC ERRORS DUE TO THE SIMULTANEOUS PROCESSING OF SENSOR OUTPUTS DURING VIBRATIONAL INPUTS. THESE FACTORS ARE ESPECIALLY CRITICAL IN A STRAPDOWN GUIDANCE SYSTEM. IN ASSESSING THE ACCURACY OF A PARTICULAR SYSTEM, IT IS, THEREFORE, NECESSARY TO CONSIDER BOTH THE DYNAMIC ERROR AND THE LAUNCH VEHICLE ENVIRONMENT AT THE SYSTEM MOUNTING LOCATION. THE SPIN STABILIZED MODE OF A THIRD STAGE REQUIRES THE DEVELOPMENT OF A SPECIAL ANTENNA FOR HIGH QUALITY TELEMETRY DATA RECEPTION. A PROGRAM HAS BEEN UNDERTAKEN TO STUDY, FABRICATE, AND FLIGHT TEST AN S-BAND ANTENNA CONFIGURATION ON THE DELTA THIRD STAGES. A STUDY TO ANALYZE THE BEHAVIOR OF SEVERAL PROPOSED SIMPLIFIED GUIDANCE SCHEMES FOR SPECIFIC ADVANCED UNMANNED MISSIONS IN AN ATTEMPT TO ESTABLISH THE CRITERIA ON WHICH A JUDGEMENT MAY BE MADE ABOUT THE RELATIVE MERITS OF ONE MODE OVER ANOTHER. THE STUDY SHOULD RESULT IN THE DEVELOPMENT OF DESIGN INFORMATION FOR ADVANCED GUIDANCE SYSTEMS. THERE EXISTS A NEED FOR LOW THRUST INTERPLANETARY COMPUTER PROGRAMS WHICH PROVIDE THE ANALYST WITH THE CAPABILITY TO STUDY MISSIONS SUBJECT TO SUCH REALISTIC ENGINEERING CONSTRAINTS AS (1) ACCURATE PROPULSION SYSTEM MODELS, (2) VEHICLE AND MISSION DEPENDENT POINTING AND STEERING REQUIREMENTS AND (3) ENVIRONMENT DISTURBANCES. UNDER THIS TASK SUCH PROGRAMS ARE BEING DEVELOPED. SPECIFICALLY PROGRAMS ARE UNDER DEVELOPMENT FOR (1) APPROXIMATE ERROR ANALYSIS AND (2) SIMULTANEOUS OPTIMIZATION OF TRAJECTORY AND PROPULSION SYSTEM.

RTOP NO. 180-17-50 TITLE: ASTRIONIC/AVIONIC SYSTEM PERFORMANCE
EVALUATION

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: CRAWFORD, R. TEL. 205-453-0480

TECHNICAL SUMMARY

EFFECTIVENESS EVALUATION TECHNIQUES ARE BEING DEVELOPED THAT CAN BE USED IN SYSTEM EVALUATION OF ASTRIONIC/AVIONIC SYSTEMS. AS DEVELOPMENT PROCEEDS, OTHER VEHICLE SYSTEMS AND PAYLOADS CAN BE INCLUDED. THE TECHNIQUES PROVIDES A MEASURE OR INDEX OF SYSTEM PERFORMANCE AND MAKES USE OF SYSTEM PARAMETERS, SUCH AS WEIGHT, POWER, RELIABILITY AND ACCURACY. THE EFFECTIVENESS EVALUATION TECHNIQUES ARE IMPLEMENTED ON A COMPUTER TO PROVIDE VARIOUS LEVELS OF SYSTEM EVALUATION. THESE LEVELS OF EVALUATION INCLUDE SENSITIVITY ANALYSIS AND A METHOD SIMILAR TO STEEPEST DESCENT FOR OPTIMUM SYSTEM SELECTION.

RTOP NO. 180-17-50 TITLE: ASTRIONICS SYSTEMS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: DRALEY, E. C. TEL. 703-827-3285

TECHNICAL SUMMARY

A FEASIBILITY STUDY WILL BE CONDUCTED TO DEFINE A GUIDANCE AND CONTROL SYSTEM CONCEPT FOR APPLICATION TO THE FINAL STAGE OF A LAUNCH VEHICLE, BASED ON TRADE-OFF STUDIES, STABILITY AND CONTROL ANALYSES, GUIDANCE AND TRAJECTORY ERROR EVALUATIONS, AND A PRELIMINARY DESIGN UTILIZING THE CONCEPT SELECTED. TRADE-OFF STUDIES WILL EMPHASIZE VERSATILITY OF USE IN SATISFYING VARIED MISSION REQUIREMENTS, CAPABILITY FOR IMPROVING VEHICLE OVERALL PERFORMANCE ACCURACY, AND MINIMAL IMPACT ON VEHICLE INTERFACE CHANGES, SYSTEM WEIGHT, AND COST OF IMPLEMENTATION. ALSO, A SURVEY OF INDUSTRY AND GOVERNMENT AGENCIES WILL BE CONDUCTED TO DETERMINE THE AVAILABILITY OF A STATE-OF-THE-ART INERTIAL GUIDANCE (MINIATURIZED GIMBAL OR STRAP-DOWN, CONVENTIONAL GYROS OR LASER GYROS) SYSTEMS WHICH COULD BE UTILIZED IN LAUNCH VEHICLES OR AIRCRAFT. EVALUATION POINTS WILL BE WEIGHT, VOLUME, COST, EASE OF MAINTENANCE, RELIABILITY, AND ACCURACY.

RTOP NO. 180-17-52 TITLE: SYSTEM AND TRAJECTORY ANALYSIS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: CRAWFORD, R. TEL. 205-453-0480

TECHNICAL SUMMARY

OBJECTIVE: TO DETERMINE THE EFFECTS OF POWERED FLIGHT FORCING FUNCTIONS ON THE NAVIGATION ERRORS OF INERTIAL GUIDANCE SYSTEMS. APPROACH: THE APPROACH SHOULD CONSIST OF, BUT NOT BE LIMITED TO: 1. DEFINE A REALISTIC DYNAMIC-ERROR MODEL RELATING LINEAR AND ANGULAR VEHICLE VIBRATIONS TO THE OUTPUTS OF SELECTED GYROS AND ACCELEROMETERS. 2. EXTEND THE STATISTICAL EVALUATION OF PROPAGATED NAVIGATION ERROR FOR TYPICAL SYSTEMS AND MISSIONS TO INCLUDE ON-BOARD COMPUTER HARDWARE AND SOFTWARE ERRORS. 3. DETERMINE HOW TO CHARACTERIZE ACTUAL VEHICLE VIBRATION IN A REALISTIC MANNER FOR USE IN STATISTICAL EVALUATION OF NAVIGATION ERRORS. NASA RELATED ACTIVITY: THE DELTA PROJECT OFFICE, GSFC, IS PROCURING A STRAPDOWN

INERTIAL GUIDANCE SYSTEM FOR USE ON FUTURE DELTA LAUNCHES. AS PART OF THE IN-FLIGHT TEST PROGRAM, VIBRATION INPUTS TO THE INSTRUMENTS WILL BE MEASURED, AND AN ATTEMPT WILL BE MADE TO CORRELATE THESE VIBRATIONS TO GYRO AND ACCELEROMETER OUTPUTS.

RTOP NO. 180-17-53 TITLE: DYNAMIC TESTS OF INERTIAL SENSORS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: CRAWFORD, R. TEL. 205-453-0480
TECHNICAL SUMMARY

OBJECTIVE: TO DETERMINE THE PERFORMANCE QUALITY OF INERTIAL SENSORS DESIGNED FOR ASTRIONICS APPLICATIONS. APPROACH: 1. DETERMINE THE SUITABILITY OF EXISTING METHODS AND EQUIPMENT FOR DYNAMIC TESTS OF INERTIAL SENSORS DEVELOPED AS EXPERIMENTAL PROTOTYPES FOR ASTRIONICS APPLICATIONS. 2. DEVELOP THE NECESSARY TEST DATA REDUCTION METHODS. 3. EVALUATE THE SENSOR COEFFICIENTS OF DESIGNATED ERROR MODELS FOR ASTRIONICS SYSTEMS, WITH AND WITHOUT ANY ERROR COMPENSATION EQUIPMENT. 4. CONDUCT PERFORMANCE TESTS WITH THE INERTIAL SENSORS COMBINED INTO AN ASTRIONICS SENSOR PACKAGE. NASA RELATED ACTIVITY: A PROGRAM TO DEVELOP TEST METHODS AND TECHNIQUES FOR EVALUATING STRAPDOWN INERTIAL SENSOR COEFFICIENTS WAS CONDUCTED BY ERC UNDER CONTRACT NAS12-678 WITH THE ANALYTICAL SCIENCES CORPORATION OF WINCHESTER, MASSACHUSETTS.----

RTOP NO. 180-17-54 TITLE: GUIDANCE COMPUTER TECHNOLOGY
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: CRAWFORD, R. TEL. 205-453-0480
TECHNICAL SUMMARY

THE COMING DECADE OF VIGOROUS SPACE ACTIVITY BY NASA AND OTHER ORGANIZATIONS WILL REQUIRE AN INCREASINGLY RELIABLE LAUNCH VEHICLE FAMILY. THIS INCLUDES THE DEVELOPMENT OF TECHNOLOGY TO PROVIDE FLEXIBLE AND RELIABLE GUIDANCE COMPUTATION FOR FUTURE SPACE MISSIONS. HIGH PERFORMANCE DATA PROCESSING CONFIGURATIONS WITH USEFUL LIFETIMES UP TO FIVE YEARS FOR LONG DURATION EARTH ORBITAL AND PLANETARY MISSIONS ARE TO BE EMPHASIZED. DIGITAL LOGIC, CIRCUITS AND PACKAGING TECHNIQUES ARE TO BE DEVELOPED TO MEET THE RELIABILITY AND ENVIRONMENTAL CONSTRAINTS OF THESE ADVANCED MISSIONS. EMPHASIS WILL BE GIVEN TO CONTINUATION OF RESEARCH IN MODULAR COMPUTER CONFIGURATIONS INCLUDING EVALUATION OF A MODULAR COMPUTER BREADBOARD WHICH HAS BEEN DEVELOPED AND FABRICATED BY NASA'S ELECTRONICS RESEARCH CENTER. EXISTING SOFTWARE WILL BE REFINED AND EXPANDED AND NEW SOFTWARE DEVELOPED IN THE AREAS OF FAILURE DETECTION, SWITCHING CONTROL, AND RECOVERY. THE CULMINATION OF THESE DEVELOPMENTS AND EVALUATIONS WILL RESULT IN THE FABRICATION OF A PROTOTYPE MODULAR COMPUTER SYSTEM UTILIZING LSI TECHNOLOGY. ASSOCIATED SOFTWARE WILL BE DEVELOPED CONCURRENTLY.

RTOP NO. 180-19-50 TITLE: REACTION CONTROL SYSTEMS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: DRALEY, E. C. TEL. 703-827-3285
TECHNICAL SUMMARY

A STUDY WILL SELECT A THRUST REDUCTION METHOD AND IDENTIFY THE NECESSARY MODIFICATIONS TO A TYPICAL REACTION CONTROL SYSTEM RELATIVE TO WEIGHT, SPACE, AND OPERATION, INCLUDING STRUCTURAL-CONTROL SYSTEM COUPLING. POSSIBLE CHANGES TO A TYPICAL GUIDANCE SYSTEM DESIGN AND PERFORMANCE PARAMETERS AS A RESULT OF THE CONTROL SYSTEM MODIFICATIONS WILL BE INVESTIGATED. ALSO, DESIGN, DEVELOPMENT, AND QUALIFICATION FOR FLIGHT WILL BE DONE ON A FINAL STAGE SOLID ROCKET MOTOR THAT WILL ENABLE A SPACE LAUNCH VEHICLE TO HAVE A PARKING ORBIT CAPABILITY. STUDY AND DEMONSTRATION WILL BE DONE ON THE ROCKET MOTOR COMPONENTS, NOZZLE, CASE, PROPELLANT, AND IGNITER TO ELIMINATE ANY DEGRADING OF THESE COMPONENTS DURING COOL DOWN AND REHEATING OF THESE COMPONENTS DURING THE SECOND FIRING. DESIGN, DEVELOPMENT, AND QUALIFICATION WILL ALSO BE DONE FOR THE QUENCH AND RE-IGNITION SYSTEMS. THIS CAPABILITY WILL PROVIDE ADDITIONAL VERSATILITY OF USE IN SATISFYING VARIED MISSION REQUIREMENTS WITH MINIMAL IMPACT ON VEHICLE INTERFACE CHANGES, SYSTEM WEIGHT, AND COST OF IMPLEMENTATION.

RTOP NO. 180-24-51 TITLE: ENGINEERING INSTRUMENTATION
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. J. TEL. 213-354-2546
TECHNICAL SUMMARY

THIS IS AN APPLIED RESEARCH PROGRAM DESIGNED TO DEVELOP AND DEMONSTRATE NON-DESTRUCTIVE TEST TECHNIQUES FOR ELECTRO-EXPLOSIVE DEVICES. INSTRUMENTATION IS BEING DEVELOPED TO MEASURE THE THERMAL CHARACTERISTICS OF THE BRIDGEWIRE AND ITS SURROUNDINGS. THIS INFORMATION WILL BE UTILIZED TO EVALUATE THE INTEGRITY OF THE DEVICE BY IDENTIFYING EXISTING ANOMOLIES. DEVICES WITH KNOWN ANOMOLIES WILL BE TESTED TO CORRELATE THE DATA WITH PARTICULAR TYPE OF DISCREPANCIES SUCH AS POOR BRIDGE WIRE WELDS AND INTIMACY OF THE EXPLOSIVE TO THE BRIDGEWIRE. THE RESULTS OF THIS EFFORT SHOULD PERMIT MEANINGFUL IN-PROCESS AND ACCEPTANCE INSPECTION OF EACH DEVICE REDUCING THE NUMBER OF DEVICES THAT MUST BE DESTRUCTIVELY TESTED TO ATTAIN A REQUIRED LEVEL OF CONFIDENCE.

RTOP NO. 180-31-50 TITLE: TANKAGE & TANKAGE MATERIALS DEVELOPMENT
AND EVALUATION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SMITH, G. T. TEL. 216-433-4000
TECHNICAL SUMMARY

THE WORK CONDUCTED UNDER THIS RTOP WILL BE DIRECTED TOWARD PROVIDING DATA, DESIGN TECHNIQUES, AND APPLIED TECHNOLOGY USEFUL IN THE DESIGN OF LOW COST, HIGH PERFORMANCE, RELIABLE PRESSURE VESSELS FOR SPACE VEHICLES. BOTH METALLIC AND FILAMENT-WOUND COMPOSITE VESSEL TECHNOLOGIES WILL BE OF INTEREST. INVESTIGATION OF THE USE OF FRACTURE MECHANICS FOR MATERIAL SELECTION, PROOF TESTING, ESTABLISHMENT OF OPERATIONAL CONDITIONS, AND PREDICTION OF

OPERATIONAL LIFE WILL BE ONE IMPORTANT AREA OF WORK. IN THIS SAME AREA, INSPECTION OF MATERIALS BY SELECTED NONDESTRUCTIVE TESTING TECHNIQUES TO QUANTITATIVELY RESOLVE FLAW SIZES AND GEOMETRIES WILL BE EVALUATED. FILAMENT-WOUND COMPOSITE PRESSURE VESSELS FOR CONTAINMENT OF CRYOGENIC FLUIDS WILL ALSO BE DEVELOPED AND DEMONSTRATED. DESIGN DATA FOR REQUIRED METALLIC LINERS AND FOR THE FILAMENT-WOUND COMPOSITE SHELL WILL BE OBTAINED OVER A TEMPERATURE RANGE DOWN TO MINUS 423 DEGREES F.

RTOP NO. 180-31-51 TITLE: INTEGRATION OF THE H-1 ENGINE TO THE UBT THOR

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: HALTERMANN, R. L. TEL. 301-982-4258

TECHNICAL SUMMARY

A DETAILED DESIGN EFFORT WILL BE CONDUCTED BY THE MCDONNELL DOUGLAS COMPANY (MDAC) AND THE ROCKETDYNE DIVISION OF THE NORTH AMERICAN ROCKWELL COMPANY TO INTEGRATE THE SATURN I-B H-1 ENGINE TO THE UNIVERSAL BOATTAIL (UBT) THOR. THE MARSHALL SPACE FLIGHT CENTER WILL ASSIST THE GODDARD SPACE FLIGHT CENTER IN THIS EFFORT. THE DETAILED DESIGN EFFORT WILL ENTAIL THE SECURING OF FIRM QUOTES FROM BOTH CONTRACTORS FOR THEIR RESPECTIVE PORTIONS OF THE TOTAL INTEGRATION PROGRAM. BACKGROUND INVESTIGATIONS UNDERTAKEN BY THE GODDARD SPACE FLIGHT CENTER IN THE FORM OF AN ENGINEERING FEASIBILITY STUDY AND COST ANALYSIS SUBSTANTIATE THE VALIDITY FOR INITIATING THIS EFFORT. THE ENGINEERING STUDY CONCLUDED THAT THE INTEGRATION OF H-1 ENGINE TO THE UBT THOR IS TECHNICALLY FEASIBLE WITH CERTAIN MODIFICATIONS TO BOTH SIDES OF THE INTERFACE. THE COST ANALYSIS DETERMINED THAT APPROXIMATELY 21 MILLION DOLLARS COULD BE SAVED OVER A FIVE YEAR PERIOD THROUGH THE DEPLOYMENT OF THIS EXISTING ENGINE. MOTIVATING THIS EFFORT ARE 39 SURPLUS H-1 ENGINES IN THE MARSHALL SPACE FLIGHT CENTER'S INVENTORY RESULTING FROM AN EARLY TERMINATION OF THE SATURN I-B PROGRAM. THE UTILIZATION OF THESE SURPLUS ENGINES WILL EFFECT A COST SAVINGS TO THE GOVERNMENT AND AT THE SAME TIME INCREASE THE PERFORMANCE OF THE THOR BOOSTER.

RTOP NO. 180-31-52 TITLE: SPACECRAFT LIQUID PROPULSION TECHNOLOGY

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MEEKS, P. J. TEL. 213-354-2546

TECHNICAL SUMMARY

THE REQUIREMENTS FOR A MIDCOURSE PROPULSION SYSTEM CAPABLE OF MULTIPLE FIRINGS DURING A LONG-DURATION (ONE DECADE) MISSION, AND THE INTERFACE CONSTRAINTS PLACED UPON THE PROPULSION SYSTEM WHICH ARISE FROM INTEGRATING THE SYSTEM WITH THE ATTITUDE PROPULSION SYSTEM AND OTHER SYSTEMS OF AN ADVANCED SPACECRAFT WILL BE DETERMINED. BASED UPON THESE REQUIREMENTS, THE DESIGN, FABRICATION AND TEST OF A PROTOTYPE SYSTEM WILL BE CONDUCTED IN ORDER TO DETERMINE FEASIBILITY AND DISCOVER ANY UNFORESEEN SYSTEM OR ENVIRONMENTAL INTERACTIONS. EXISTING COMPONENTS WILL BE USED AS AVAILABLE. THE TECHNOLOGY EVOLVING FROM THIS WORK WILL DIRECTLY SUPPORT THE THERMOELECTRIC OUTER PLANET SPACECRAFT (TOPS) ADVANCED DEVELOPMENT. A FURTHER

OBJECTIVE IS TO DESIGN, FABRICATE, DEMONSTRATE, AND DEVELOP TO FLIGHT PROTOTYPE STATUS A 1000 LB. SUB F BIPROPELLANT ROCKET ENGINE FOR UNMANNED PLANETARY SPACECRAFT APPLICATIONS. THE ENGINE WILL USE EARTH STORABLE PROPELLANTS (N2O4 WITH MMH OR N2H2), WILL BE CAPABLE OF OPERATING FOR 1000 SECONDS IN ONE CONTINUOUS BURN, AND WILL BE CAPABLE OF A MINIMUM OF 6 RESTARTS. IT IS PLANNED TO DEVELOP AND DEMONSTRATE THE ENGINE BY 1972, SO THAT IT CAN BE INCORPORATED INTO SPACECRAFT SCHEDULED FOR LAUNCH AS EARLY AS 1975. IN ADDITION THE EVALUATION OF THE HIGH-THRUST, THROTTLEABLE HYDRAZINE ENGINES WILL BE COMPLETED BY EXPOSING AND SOLVING ANY UNFORESEEN OPERATIONAL PROBLEMS ASSOCIATED WITH THRUST CHAMBER/THROTTLE VALVE COMBINATIONS. BEGINNING IN FY'72 AN EFFORT ON IMPROVED MAIN PROPULSION FOR SPACECRAFT WILL BE STARTED. THIS WILL BE STRUCTURED LIKE THE MONOPROPELLANT UNIT FOR TEN-YEAR MISSIONS, BUT WILL CONCENTRATE ON IMPROVED BIPROPELLANT SYSTEMS CAPABLE OF ORBIT INSERTION AS WELL AS MIDCOURSE MANEUVERS AND ORBIT MODIFICATIONS.

RTOP NO. 180-32-50 TITLE: ORBITAL INJECTION ACCURACY OF
SPIN-STABILIZED SOLID MOTORS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: DEMBROW, D. W. TEL. 301-982-5710

TECHNICAL SUMMARY

THE CAPABILITY OF A LAUNCH VEHICLE TO ACHIEVE A PRECISE INJECTION VELOCITY IS LIMITED WHEN A SPIN STABILIZED SOLID PROPELLANT MOTOR IS USED AS THE FINAL STAGE. THE ERROR IN INJECTION VELOCITY OCCURS BECAUSE OF THE UNCERTAINTY IN PREDICTING THE SPECIFIC IMPULSE AND TOTAL PROPELLANT WEIGHT FOR A GIVEN SOLID PROPELLANT MOTOR. ALTHOUGH THESE ERRORS ARE SMALL, THEIR ACCUMULATIVE EFFECT CAN, IN THE CASE OF THE DELTA VEHICLE, ACCOUNT FOR AS MUCH AS 70% OF THE TOTAL VEHICLE ERROR IN INJECTION VELOCITY. TO REDUCE THE OVERALL INJECTION VELOCITY ERROR OF THE VEHICLE, IT IS DESIRABLE TO MINIMIZE THE CONTRIBUTION FROM THE SPIN STABILIZED SOLID MOTOR. A SIMPLE MEANS FOR CONTROLLING THE VELOCITY IMPARTED BY THE SOLID MOTOR IS TO UTILIZE THE FULL EXPENDITURE OF PROPELLANT FROM THE SOLID MOTOR AND MERELY PROVIDE ADDITIONAL THRUST FROM A SUPPLEMENTARY SYSTEM TO TRIM THE VELOCITY TO THE DESIRED LEVEL. OTHER SCHEMES ARE FEASIBLE SUCH AS A N2H4 MONOPROPELLANT OR SMALL HYBRID SYSTEM.

RTOP NO. 180-32-51 TITLE: SOLID PROPELLANT PROPULSION SYSTEMS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: DRALEY, E. C. TEL. 703-827-3285

TECHNICAL SUMMARY

A REVIEW WILL BE MADE OF THE CRITERIA AND METHODS OF ANALYSIS USED IN THE DESIGN, PROCESSES, AND TECHNIQUES USED IN THE FABRICATION OF SOLID FUEL ROCKET MOTORS, PARTICULARLY THOSE USED IN THE SCOUT VEHICLE, AND IDENTIFY THOSE AREAS WHERE THE DESIGN AND/OR PROCESS CONTROLS ARE INADEQUATE. A STUDY WILL BE PERFORMED TO DEFINE THE EXTENT AND SEVERITY OF THE SOLID ROCKET MOTOR OUTGASSING. OPTIMUM MOTOR CASE MATERIALS AND/OR FABRICATION TECHNIQUES WILL BE SELECTED. AN INVESTIGATION WILL BE CONDUCTED TO DETERMINE AND VERIFY BY TESTS A

TECHNIQUE FOR PREDICTING THE AERODYNAMIC COEFFICIENTS OF CONTROL SURFACES IMMERSED IN A ROCKET EXHAUST FLOW EXTERNAL TO THE NOZZLE. A STUDY WILL SURVEY THE EXISTING MOTORS, DEFINE AN OPTIMUM CONFIGURATION FOR AN UPPER STAGE MOTOR, AND SELECT ONE OR MORE CANDIDATES AS THE STARTING POINT FOR DEVELOPMENT OF THE OPTIMUM MOTOR. THE APOLLO STANDARD INITIATOR WILL BE QUALIFIED TO A DELAY INITIATOR ASSEMBLY IN A MODULAR CONCEPT. IN THIS CONCEPT, THE APOLLO STANDARD INITIATOR SHALL BE USED TO FUNCTION HIGHER LEVEL HERMETICALLY-SEALED PYROTECHNIC ASSEMBLIES. SEPARATE MOTOR DELAY INITIATOR ASSEMBLIES WILL BE DEVELOPED TO MEET THREE DIFFERENT SPECIFIED CONDITIONS. AN INVESTIGATION WILL BE MADE TO EVALUATE THE EFFECTIVENESS OF RADIOGRAPHIC AND ULTRASONIC NONDESTRUCTIVE TEST METHODS CURRENTLY USED FOR DETERMINING THE ACCEPTANCE OF SOLID PROPELLANT MOTORS. METHODS FOR UPGRADING THE QUALITY OF NONDESTRUCTIVE TEST ACCEPTANCE CRITERIA, THROUGH IMPROVEMENTS IN EXISTING EQUIPMENT AND PROCEDURES, AND/OR THE USE OF ADVANCED TECHNIQUES WILL ALSO BE INVESTIGATED. A DEVELOPMENT PROGRAM WILL BE CONDUCTED TO DETERMINE THE SELECTION OF AN IMPROVED MATERIAL TO REPLACE GRAPHITE MATERIALS CURRENTLY USED FOR NOZZLE THROAT INSERTS ON SOLID PROPELLANT MOTORS. A PROGRAM WILL IDENTIFY THE CRITICAL DESIGN PARAMETERS THAT AFFECT THE RELIABILITY OF PYROTECHNIC SYSTEMS SO THAT LOW COST, SIMPLE, AND RELIABLE SYSTEMS CAN BE USED.

RTOP NO. 180-59-51 TITLE: SOLAR ELECTRIC PROPULSION
SPACECRAFT/STAGE PROGRAM COST ESTIMATION
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. J. TEL. 213-354-2546
TECHNICAL SUMMARY

THE GENERAL OBJECTIVE OF THIS TASK IS TO ASSESS AND DOCUMENT CURRENT COST ESTIMATION TECHNIQUES AS APPLIED TO SOLAR ELECTRIC SPACECRAFT, AND TO EFFECT SUFFICIENT MODIFICATION IN THE COSTING METHODOLOGY AND DATA BANK TO ESTABLISH THAT CONFIDENCE IN SEP SPACECRAFT PROGRAM COST ESTIMATES NEEDED FOR PROGRAMMATIC DECISION MAKING AT JPL AND NASA HEADQUARTERS. THE OUTPUT OF THE TASK WOULD BE A COST ESTIMATING METHOD THAT WOULD TAKE PROGRAMMATIC GROUND RULES WITH REGARD TO TESTING, SPARES, ETC., DEVELOP A VALID WORK BREAKDOWN STRUCTURE, SUBSYSTEM REQUIREMENTS AND ASSOCIATED COSTS, INTEGRATION COSTS, AND OPERATIONAL COSTS TO ARRIVE AT A TOTAL PROGRAM COST IN TERMS OF RECURRING AND NON-RECURRING ELEMENTS. COST MODELS WILL BE DEVELOPED FOR BOTH MAJOR SUBSYSTEMS, THE POWER SUBSYSTEM CONSISTING PRIMARILY OF THE LARGE SOLAR ARRAY, ITS CABLING AND DEPLOYMENT STRUCTURE, AND THE THRUST SUBSYSTEM CONSISTING PRIMARILY OF THE THRUSTERS, THE FEED SYSTEM, THE THRUST VECTOR POSITION ADJUSTMENT LOGIC AND MECHANISMS, AND THE POWER CONDITIONING. NECESSARY DATA BANK INFORMATION WILL BE ASSEMBLED FOR THESE SUBSYSTEMS TO FIT THE NEEDS OF THE COST MODELS. APPROPRIATE SUBSYSTEM TEST PROGRAMS WILL BE DEFINED SUFFICIENTLY FOR COSTING PURPOSES AS WILL THE APPROPRIATE SPACECRAFT INTEGRATION, QUALIFICATION AND FUNCTIONAL CHECKOUT TESTING. FINALLY, THE METHODOLOGY OF ESTIMATING SPACECRAFT PROGRAM MANAGEMENT, GROUND HANDLING, LAUNCH, AND OPERATIONS COSTS WILL BE EXAMINED AND MODIFIED AS NECESSARY TO APPLY TO SEP SPACECRAFT PROGRAMS. A COSTING METHODOLOGY THAT BUILDS CONFIDENCE IN THE MINDS

OF THE PROGRAM PLANNERS AND MANAGERS IS CONSIDERED VITAL TO A TIMELY AND AFFIRMATIVE DECISION TO APPLY SEP TO FUTURE MISSIONS.

RTOP NO. 185-47-51 TITLE: ABSOLUTE PRESSURE, ATOMIC OXYGEN, AND
ENERGETIC BEAM CALIBRATION FOR MASS
SPECTROMETERS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: NIEMANN, H. B. TEL. 301-982-5776

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP LABORATORY TECHNIQUES AND CONSTRUCT TEST FACILITIES FOR THE TESTING AND CALIBRATION OF INSTRUMENTS TO MEASURE THE NEUTRAL PARTICLE COMPOSITION AND TEMPERATURE IN THE ATMOSPHERE. THE LARGE PRESSURE RANGE OVER WHICH THE INSTRUMENTS ARE REQUIRED TO OPERATE AND THE DIFFERENT CHEMICAL PROPERTIES OF THE VARIOUS ATMOSPHERIC CONSTITUENTS MAKE IT NECESSARY TO BUILD SEVERAL SEPARATE SYSTEMS EACH WITH A LIMITED RANGE AND FLEXIBILITY WHICH TOGETHER SATISFY THE TEST REQUIREMENTS. AN ABSOLUTE PRESSURE CALIBRATION SYSTEM WILL BE CONSTRUCTED FOR MASS SPECTROMETER CALIBRATION WITH NON-REACTIVE GASES, I.E., N₂, O₂, CO₂, ETC., AND NOBLE GASES. A DUAL CHAMBER SYSTEM WITH LIQUID HELIUM CRYOGENIC PUMPS AND SPUTTER ION PUMPS WILL BE USED IN ORDER TO PROVIDE FOR LARGE PUMPING LOW ULTIMATE PRESSURE AND HYDROCARBON FREE OPERATIONS. PRESSURE MEASUREMENT WITH REFERENCE MANOMETER AND HIGH SPEED COMPUTER COMPATIBLE DATA RECORDING ASSURES IMPROVED MEASUREMENT ACCURACY AND HIGH EFFICIENCY. FOR THE EVALUATION AND CALIBRATION OF SPECTROMETERS WITH CHEMICALLY ACTIVE GASES, I.E., O, H, THE PRESENTLY EMPLOYED ATOMIC BEAM SYSTEM WILL BE MODIFIED TO PERMIT OPERATION OVER A WIDER ATOMIC FLUX RANGE AND TO IMPROVE MEASUREMENT ACCURACY. THE ATOMIC BEAM SYSTEM PRODUCES AN ATOMIC OXYGEN BEAM BY THERMAL DISSOCIATION ON HOT METAL SURFACES WITH AN EFFICIENCY OF LARGER THAN 70%. ATOMIC CONCENTRATIONS OF MORE THAN 90% HAVE BEEN OBTAINED AT FLUX LEVELS OF ABOUT 10 TO THE 13TH POWER ATOMS/CM SQ. CM SEC. AND OVER A CROSS SECTIONAL AREA OF 1 CM SQ. CM. DIRECT FLIGHT SIMULATION AND BASIC GAS SURFACE INTERACTION STUDIES CAN BE PERFORMED WITH THIS EQUIPMENT. AN INTERMEDIATE ENERGY ATOMIC BEAM SYSTEM WHICH WORKS ON A SPUTTERING PRINCIPLE IS BEING TESTED IN A BREADBOARD TYPE STATE. IT IS INTENDED TO GENERATE ATOMIC OXYGEN AND ATOMIC NITROGEN BEAMS WITH A KINETIC ENERGY RANGING FROM 1 TO 10 EV.----

RTOP NO. 185-47-52 TITLE: DEVELOPMENT OF NEUTRAL MASS SPECTROMETERS
FOR PLANETARY ATMOSPHERE EXPERIMENTS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: SPENCER, N. W. TEL. 301-982-5001

TECHNICAL SUMMARY

THE RESEARCH UNDER THIS RTOP IS CONCERNED WITH: (1)
DEVELOPMENT OF QUADRUPOLE MASS SPECTROMETERS, INCLUDING (A) SMALLER,
LIGHTER, HIGHER RESOLUTION, AND SIMPLIFIED AND HENCE LESS EXPENSIVE

ANALYZERS USING HYPERBOLIC RODS. (B) IMPROVED, MORE ACCURATE, SENSITIVE AND STABLE ION DETECTORS GENERALLY APPLICABLE TO DIGITAL SPACE SYSTEMS, (C) MORE EFFICIENT ION SOURCES OF THE "OPEN" TYPE TO PROVIDE SIDE-ENERGY FOCUSING, (D) MORE EFFICIENT ION SOURCES OF THE CLOSED TYPE TO MINIMIZE ANY CHANGE OF THE GAS BEING MEASURED WHILE INCREASING THE THERMALIZATION OF THE GAS. (2) FLIGHT TEST BREADBOARD AS PROTOTYPE INSTRUMENTS IN ROCKETS AND PROBES TO ESTABLISH THE VALIDITY OF NEW TECHNIQUES IN INSTRUMENTATION APPLICATION AND ANALYSIS FOR FUTURE APPLICATION. (3) CONDUCT STUDIES AND RESEARCH IN THE APPLICATION OF INSTRUMENTS FOR COMPOSITION MEASUREMENTS IN ATMOSPHERES OF HIGH DENSITY (E.G. VENUS) AND LOW DENSITY (UPPER ATMOSPHERE OF ALL PLANETS) TO INSURE DETECTION OF A TRUE SAMPLE OF THE ATMOSPHERE. (4) DEVELOP NEW ELECTRONIC TECHNIQUES FOR USE WITH QUADRUPOLE INSTRUMENTS EMPLOYING DIGITAL TECHNIQUES, TO ACHIEVE GREATER SIMPLICITY, STABILITY AND RELIABILITY.

RTOP NO. 185-47-53 TITLE: DEVELOPMENT OF ION MASS SPECTROMETERS FOR PLANETARY ATMOSPHERES EXPERIMENT

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: TAYLOR, H. A., JR. TEL. 301-982-6610

TECHNICAL SUMMARY

A COORDINATED DEVELOPMENT, INCLUDING SENSOR UTILIZATION AND ASSOCIATED PLASMA PHYSICS INTERPRETATION, WILL BE PERFORMED TO OPTIMIZE EXISTING ION MASS SPECTROMETER MEASUREMENT TECHNIQUES IN ANTICIPATION OF FUTURE OPPORTUNITIES FOR THE EXPLORATION OF PLANETARY ATMOSPHERES. THE BENNETT RF ION SPECTROMETER EXPERIMENT HAS BEEN USED EXTENSIVELY IN BOTH ROCKET AND SATELLITE INVESTIGATIONS OF THE EARTH'S ATMOSPHERE, AND PRESENT TECHNIQUES HAVE PROVEN QUITE SUCCESSFUL FOR SUCH PURPOSES. CHARACTERISTICS OF FUTURE MISSIONS SUCH AS THE LOW ALTITUDE ATMOSPHERIC EXPLORER SATELLITE AND THE PLANETARY EXPLORER SATELLITE, HOWEVER, IMPOSE NEW TECHNICAL REQUIREMENTS. IN THE CASE OF THE PLANETARY EXPLORER, MISSION CONSTRAINTS PLACE AN EMPHASIS ON MINIMIZING THE WEIGHT, POWER, AND DATA REQUIREMENTS OF EXPERIMENTS, WHILE AT THE SAME TIME IMPROVING RELIABILITY AND REDUCING COSTS. AN EVALUATION OF PRESENTLY AVAILABLE SENSOR FABRICATION AND OPERATING TECHNIQUE OPTIONS WILL BE MADE IN ORDER TO OBTAIN THE BEST POSSIBLE BALANCE OF EFFICIENCY, RELIABILITY, AND REDUCED COST. IN THE CASE OF THE LOW ALTITUDE EARTH SATELLITE, NEW AND UNIQUE PLASMA FLOW PROBLEMS ARE ANTICIPATED IN THE 150-120 KM. ALTITUDE REGION AS PERIGEE MOVES FROM THE FREE MOLECULAR FLOW TO THE VISCOUS FLOW REGIME IN THE ATMOSPHERE. AN EXTENSION OF EXISTING PLASMA PHYSICS-ION FLOW STUDIES WILL BE PERFORMED, TO EXAMINE ION MASS DISCRIMINATION EFFECTS WHICH COULD RESULT FROM THE POSSIBLE FORMATION OF PERTURBATIONS SUCH AS ION PLASMA WAVES AND OSCILLATIONS PRODUCED AT THE INTERFACE OF THE LEADING SURFACE OF THE SATELLITE AND THE HIGH DENSITY PLASMA. THIS STUDY, INCLUDING THE EXAMINATION OF THE EFFECT OF THE CHARGED-NEUTRAL COLLISIONS ON THE FLOW FIELD OF THE CHARGED PARTICLE FLUX TO THE SATELLITE SURFACE WILL ALSO RELATE CLOSELY TO THE INTERPRETATION OF CHARGED PARTICLE DATA WHICH MAY BE OBTAINED FROM PLANETARY PROBE EXPERIMENTS.

RTOP NO. 185-47-54 TITLE: EXPERIMENT DEVELOPMENT FOR THE
DETERMINATION OF VENUS CLOUD PARTICLE
COMPOSITION

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: NIEMANN, H. B. TEL. 301-982-5776

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP A PRACTICAL TECHNIQUE FOR THE DETERMINATION OF THE COMPOSITION OF CLOUD PARTICLES IN THE LOWER ATMOSPHERE OF VENUS. ALTHOUGH THE COMPLEXITY OF THE VENUS CLOUD STRUCTURE, WHICH IS EXPECTED TO BE AT LEAST EQUAL TO THE COMPLEXITY OF THE TERRESTRIAL CLOUD STRUCTURE, REQUIRES A STUDY OF MANY DIFFERENT TECHNIQUES, THE RELATIVELY STRAIGHTFORWARD AND LABORATORY PROVEN METHOD OF MASS SPECTROMETERS FOR THE COMPOSITION DETERMINATION OF SOLID MATERIALS AND CONDENSIBLES WILL BE ADOPTED FOR SPACE FLIGHT APPLICATIONS. THE MAJOR EFFORT WILL BE EXTENDED IN THE AREA OF MINIATURIZATION, WEIGHT REDUCTION AND EFFICIENCY IN POWER CONSUMPTION.

RTOP NO. 185-47-55 TITLE: SPECTROSCOPY AND PHOTOCHEMISTRY OF
PLANETARY AND COMETARY MOLECULES

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: STIEF, L. J. TEL. 301-982-2529

TECHNICAL SUMMARY

BRIEF TECHNICAL SUMMARY/ABSTRACT. THE OBJECTIVES OF THIS PROGRAM ARE TO MEASURE THE OPTICAL AND CHEMICAL PROPERTIES OF ATOMS AND MOLECULES WHICH ARE IMPORTANT IN UNDERSTANDING THE COMPOSITION OF PLANETARY ATMOSPHERES AND COMETS. EMPHASIS IS PLACED ON THOSE PROBLEMS WHICH ARE OF IMMEDIATE CONCERN FOR INTERPRETING THE RESULTS OF ROCKET AND SATELLITE OBSERVATIONS. IN THESE INVESTIGATIONS THE WELL KNOWN TECHNIQUES OF OPTICAL SPECTROSCOPY AND OF PHOTOCHEMISTRY ARE APPLIED UNDER WELL DEFINED EXPERIMENTAL CONDITIONS. SOPHISTICATED TECHNIQUES HAVE BEEN DEVELOPED FOR DATA REDUCTION AND FOR HANDLING THE SMALL SIGNAL LEVELS WHICH ARE USUALLY ENCOUNTERED. PHOTODISSOCIATION CROSS-SECTIONS FOR MOLECULAR HYDROGEN HAVE BEEN MEASURED IN THE SPECTRAL REGION 700-860A. PHOTODISSOCIATION OF H_2 IN THIS REGION RESULTS IN THE PRODUCTION OF LYMAN-ALPHA RADIATION AND THIS PROCESS IS IMPORTANT IN THE ATMOSPHERE OF VENUS AND JUPITER. MEASUREMENTS HAVE ALSO BEEN MADE OF THE RADIATIVE LIFETIME OF THE $B(2) \Sigma^+(+)$ ELECTRONIC STATE OF $N_2(+)$. TRANSITIONS FROM THIS STATE PRODUCE THE IMPORTANT $N_2(U^+)$ FIRST NEGATIVE BAND SYSTEM WHICH IS A STRONG EMITTER IN THE AURORA. FINALLY, THE QUENCHING OF METASTABLE $O(^1D)$ ATOMS HAS BEEN STUDIED FOR DIFFERENT QUENCHING GASES.

RTOP NO. 185-47-61 TITLE: (U) SPECTROSCOPY OF PLANETARY ATMOSPHERES

ORGANIZATION: NASA-MANNED SPACECRAFT CENTER

MONITOR: HUDSON, R. D. TEL. 713-483-3816

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE, BY INFRARED AND ULTRAVIOLET SPECTROMETRIC TECHNIQUES, BOTH IN THE LABORATORY OR BY MEANS OF SOUNDING ROCKET PROBES, GROUND BASED TELESCOPES, HIGH

ALTITUDE AIRCRAFT, OR SPACE VEHICLE PLATFORMS, FUNDAMENTAL DATA WHICH CAN BE USED TO DEVELOP, AND EXPLORE THE FEASIBILITY OF SPACE FLIGHT EXPERIMENTS FOR THE DETERMINATION OF THE TEMPERATURE AND COMPOSITION OF PLANETARY ATMOSPHERES. THIS WILL BE ACHIEVED BY (1) LABORATORY STUDIES OF THE ABSORPTION OF ULTRAVIOLET LIGHT BY ATMOSPHERIC GASES AT HIGH RESOLUTION, (2) LABORATORY STUDIES OF THE CHEMICAL REACTIONS THAT LEAD TO THE PRODUCTION OF AIRGLOW, (3) USING ROCKET PROBES, HIGH ALTITUDE AIRCRAFT, AND SPACE PLATFORMS TO STUDY ATMOSPHERIC COMPOSITION, TEMPERATURE, DISSOCIATION RATES AND AIRGLOW, AND (4) TELESCOPE STUDIES OF THE ATMOSPHERES OF MERCURY, VENUS, MARS, JUPITER, AND SATURN IN THE INFRARED AT HIGH SPECTRAL RESOLUTION.

RTOP NO. 185-47-66 TITLE: ATMOSPHERIC CHEMICAL PHYSICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-1111
TECHNICAL SUMMARY

THE STRUCTURE OF A PLANETARY ATMOSPHERE IS THE RESULT OF INTERACTIONS BETWEEN THE MAJOR CONSTITUENTS OF THE ATMOSPHERE AND SOLAR, COSMIC OR GALACTIC RADIATION. THE PRODUCTS OF THESE INTERACTIONS ARE EXCITED AND GROUND-STATE ATOMS AND MOLECULES, AND IONS. THE ENERGY TRANSFER MECHANISMS THAT PRODUCE THE PRODUCTS AND THE ENSUING CHEMICAL REACTIONS BETWEEN THE PRODUCTS MUST BE INVESTIGATED IN THE LABORATORY IN ORDER TO PROVIDE DATA FOR THE INTERPRETATION OF OBSERVATIONS AND FOR THE PREPARATION OF DESCRIPTIVE AND PREDICTIVE MODELS. THE OBJECTIVE OF THIS WORK IS TO DELINEATE THE REACTIONS THAT MAY OCCUR IN PLANETARY AND COMETARY ATMOSPHERES AND TO MEASURE THEIR RATES AND EFFICIENCIES.

RTOP NO. 185-47-67 TITLE: STRUCTURE OF PLANETARY ATMOSPHERES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-1111
TECHNICAL SUMMARY

THE GOAL OF OBSERVATIONS, LABORATORY MEASUREMENTS, AND THEORETICAL INVESTIGATIONS OF PLANETARY ATMOSPHERES IS TO DEVELOP DESCRIPTIVE AND PREDICTIVE MODELS. THE MODELS ARE USEFUL FOR BOTH GEOPHYSICAL RESEARCH AND FOR THE DESIGN OF SPACECRAFT AND SYSTEMS FOR PLANETARY EXPLORATION. THE OBJECTIVE OF THIS WORK IS THE PREPARATION OF SUCH MODELS IN ORDER TO EXPLAIN THE EVOLUTION, STRUCTURE AND MAINTENANCE OF PLANETARY ATMOSPHERES. TO THIS END, ALL PERTINENT THEORY, LABORATORY MEASUREMENTS, OBSERVATIONS, AND MODELS ARE USED; THERMODYNAMICS OF EVOLVING PLANETS, PHOTOCHEMISTRY AND ION-KINETICS OF ATMOSPHERIC GASES, AND TRANSPORT PROCESSES IN ATMOSPHERES ARE CONSIDERED.

RTOP NO. 185-47-68 TITLE: PLANETARY ATMOSPHERES - STRUCTURE AND
COMPOSITION

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

THE PLANETARY ATMOSPHERE EXPERIMENTS TEST (PAET) IS BEING PERFORMED TO DEMONSTRATE, IN THE EARTH'S ATMOSPHERE, THE ABILITY OF SELECTED EXPERIMENTS, PERFORMED DURING ATMOSPHERE ENTRY, TO DETERMINE THE STRUCTURE AND COMPOSITION OF AN UNKNOWN PLANETARY ATMOSPHERE. THREE EXPERIMENTS WILL BE FLOWN: AN ATMOSPHERE STRUCTURE EXPERIMENT, A SHOCK-LAYER RADIOMETER COMPOSITION EXPERIMENT, AND A MASS SPECTROMETER COMPOSITION EXPERIMENT. DEVELOPMENT OR ACQUISITION OF INSTRUMENTATION FOR THE FIRST TWO OF THESE EXPERIMENTS IS BEING PERFORMED UNDER THIS RTOP. EXPERIMENTS OF THIS TYPE WILL BE PART OF THE PAYLOAD ABOARD THE VIKING MARS MISSION. STUDIES WILL BE PERFORMED, AS NEEDED IN RESPONSE TO REQUESTS OF THE VIKING PROJECT ENTRY SCIENCE TEAM, TO EVALUATE EFFECTS OF PROPOSED CHANGES OR TO DEVELOP NEW APPROACHES TO PLANNED EXPERIMENTS FOR THE LANDER VEHICLES. FURTHER STUDIES WILL BE MADE TO DETERMINE IMPLEMENTATION REQUIREMENTS OF THESE OR SIMILAR EXPERIMENTS FOR ENTRY INTO VENUS AND JUPITER.

RTOP NO. 185-47-71 TITLE: STUDIES OF THE ATMOSPHERES OF THE OUTER
PLANETS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BURCHAM, D. P. TEL. 213-354-3028

TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS TO DEFINE THE KEY INVESTIGATIONS TO BE CONDUCTED IN STUDYING THE ATMOSPHERES OF THE OUTER PLANETS AND, IN PARTICULAR, JUPITER AND SATURN. THE INITIAL RESULTS OF THE STUDIES SHOULD BE THE DEFINITION AND RECOMMENDATION OF CONCEPTS TO BE DEVELOPED FOR BOTH SPACE FLIGHT AND GROUND BASED EXPERIMENTS TO ACCOMPLISH THESE INVESTIGATIONS. SUPPORTING THEORETICAL AND LABORATORY STUDIES WILL BE CARRIED OUT WHICH WILL PROVIDE VERIFICATION OF CRITICAL DEVICE PERFORMANCE, OR ESSENTIAL BASIC DATA REQUIRED FOR EXPERIMENT DEVELOPMENT.

RTOP NO. 185-47-72 TITLE: THEORETICAL STUDIES--PLANETARY ATMOSPHERES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BURCHAM, D. P. TEL. 213-354-3028

TECHNICAL SUMMARY

A COMPREHENSIVE PROGRAM OF EXPERIMENTAL AND THEORETICAL STUDIES RELATED TO PLANETARY ATMOSPHERES WILL BE CONDUCTED WITH THE FOLLOWING GOALS: 1) UNDERSTANDING THE PROPERTIES OF PLANETARY ATMOSPHERES, 2) APPLYING THESE FINDINGS TOWARD THE DESIGN OF BOTH GROUND BASED AND SPACE EXPERIMENTS AND TO THE INTERPRETATION OF THE RESULTING DATA. THIS PROGRAM CONTRIBUTES TO THE PLANETARY MISSIONS IN TWO WAYS: 1) THE RESEARCH TOPICS ARE DIRECTLY RELEVANT TO PLANETARY SCIENCE, AND 2) THE PROGRAM RETAINS WITHIN JPL A STAFF OF SPECIALISTS WHO CONTRIBUTE TO THE DEFINITION OF SCIENTIFIC OBJECTIVES AND RATIONALE

FOR PLANETARY MISSIONS. THE STUDIES TO BE CONDUCTED IN FY'71 PERTAIN TO: A. PHOTOCHEMISTRY OF PLANETARY ATMOSPHERES. B. RADIATIVE TRANSPORT THEORY AND THE THEORY OF SPECTRAL LINE FORMATION. C. PLANETARY MICROWAVE STUDIES. D. ATMOSPHERIC EVOLUTION.

RTOP NO. 185-47-80 TITLE: EXPERIMENT DEVELOPMENT
ORGANIZATION: NASA HEADQUARTERS
MONITOR: FELLOWS, R. F. TEL. 202-962-1861
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP THE INSTRUMENTATION CAPABILITY REQUIRED FOR SPACECRAFT EXPLORATION AND STUDY OF PLANETARY ATMOSPHERES AND COMETARY GASES. NEW CONCEPTS WILL BE SOUGHT AND EVALUATED, AND KNOWN TECHNIQUES AND INSTRUMENTS WILL BE MODIFIED AND DEVELOPED FOR SPECIALIZED APPLICATION. STUDIES ESSENTIAL TO UNDERSTANDING THE RESPONSE AND BEHAVIOR CHARACTERISTICS OF SENSORS AND INSTRUMENTS WILL BE CONDUCTED.

RTOP NO. 185-47-81 TITLE: THEORY AND MODELS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: FELLOWS, R. F. TEL. 202-962-1861
TECHNICAL SUMMARY

THE OBJECTIVE IS TO FOSTER AND TO DEVELOP A BROAD BASE OF THEORY EXPLAINING THE PHENOMENA OF PLANETARY ATMOSPHERES INCLUDING THEIR ORIGINS, EVOLUTIONS, PRESENT STATES, AND FUTURE HISTORY.

RTOP NO. 185-47-82 TITLE: ATMOSPHERIC CHEMISTRY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: FELLOWS, R. F. TEL. 202-962-1861
TECHNICAL SUMMARY

THE OBJECTIVE IS TO SUPPORT A BROAD BASED PROGRAM OF LABORATORY INVESTIGATIONS DIRECTED AT OBTAINING DATA ESSENTIAL TO THE ANALYSIS OF FLIGHT EXPERIMENTS AND THE DEVELOPMENT OF NEW AND IMPROVED THEORIES AND EXPLANATIONS OF ATMOSPHERIC CHEMICAL PROCESSES.

RTOP NO. 185-47-83 TITLE: SPECTROSCOPIC INVESTIGATIONS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: FELLOWS, R. F. TEL. 202-962-1861
TECHNICAL SUMMARY

RESEARCH CONDUCTED UNDER THIS RTOP INCLUDES SPECTROSCOPIC, PHOTOMETRIC, AND RADIOMETRIC INVESTIGATIONS OF PLANETARY ATMOSPHERES, AND COMETS AND OF THEIR COMPONENTS, FOR THE PURPOSE OF OBTAINING INFORMATION ABOUT COMPOSITION, STRUCTURE, AND REACTIONS.

RTOP NO. 185-47-84 TITLE: CHEMISTRY OF THE OUTER PLANETS AND COMETS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: FELLOWS, R. F. TEL. 202-962-1861
TECHNICAL SUMMARY

THE OBJECTIVE OF THE RESEARCH CONDUCTED UNDER THIS RTOP IS TO OBTAIN IN THE LABORATORY, INFORMATION REQUIRED IN THE INTERPRETATION OF DATA PERTAINING TO THE OUTER PLANETS AND COMETS.

RTOP NO. 185-50-51 TITLE: PROCESSES AND MORPHOLOGY OF THE MARTIAN SURFACE

ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-1111
TECHNICAL SUMMARY

MARINERS IV, VI, AND VII HAVE REVEALED A CRATERED SURFACE ON MARS SIMILAR TO THE LUNAR HIGHLAND AND MARIA. THE MECHANISMS FOR CRATER FORMATION IS PROBABLY THE SAME FOR THE TWO BODIES. ASSUMING IMPACT IS THE DOMINANT ROLE OF CRATER FORMATION ON MARS, THE SURFACE MORPHOLOGY OF MARS SHOULD BE SIMILAR TO THE MOON EXCEPT FOR DIFFERENCES CAUSED BY THE TENUOUS MARTIAN ATMOSPHERE. THESE DIFFERENCES WILL BE MOST APPARENT IN SMALL SCALE FEATURES DUE TO DIRECT AERODYNAMIC SHIELDING AND TO EOLIAN EROSION. A MODEL FOR THE MARTIAN METEOROID ENVIRONMENT WILL BE DEVELOPED. BASED ON THIS MODEL, PRODUCTION OF CRATERS LESS THAN ABOUT 1 KILOMETER WILL BE EXAMINED. AFTER ATMOSPHERIC SHIELDING EFFECTS, CONSIDERATION WILL BE GIVEN TO THE MODIFYING INFLUENCE OF EOLIAN EROSION ON THE THEORETICAL MODEL.

RTOP NO. 185-50-51 TITLE: SEISMIC INSTRUMENT AND MAGNETIC OBSERVATORY FOR MARS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: NESS, N. F. TEL. 301-982-2215
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP A LIGHTWEIGHT, LOW POWER MAGNETIC OBSERVATORY AND TRIAXIAL SEISMOMETER TO BE PLACED ON THE SURFACE OF MARS TO STUDY THE ELECTRICAL, ELECTROMAGNETIC, MAGNETIC AND SEISMIC PROPERTIES OF MARS. THIS INFORMATION WILL PROVIDE INVALUABLE DATA CONCERNING THE PRESENT STRUCTURE AND THERMAL REGIME OF THE INTERIOR OF THE PLANET. SUCH INFORMATION IS ESSENTIAL IN ORDER TO INCREASE OUR UNDERSTANDING OF THE EVOLUTION OF THE TERRESTRIAL PLANETS AND ORIGIN OF THE SOLAR SYSTEMS. THE MAGNETIC OBSERVATORY ACCURACY AND RESOLUTION IS TO BE INCREASED FROM PLUS OR MINUS 0.125 GAMMAS TO PLUS OR MINUS 0.01 GAMMAS. A LIGHT OPTICAL ASPECT DETECTOR ON THE END OF THE BOOM PACKAGE IS REQUIRED TO DETERMINE THE ATTITUDE OF THE SENSOR PACKAGE.

RTOP NO. 185-50-52 TITLE: DISTRIBUTION OF URANIUM, THORIUM, AND
POTASSIUM IN COMAGMATIC ROCKS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: QUAIDE, W. L. TEL. 415-961-2150

TECHNICAL SUMMARY

CONCENTRATIONS OF NATURAL RADIOACTIVE ELEMENTS (U, TH, & K) CAN BE MEASURED BY NONDESTRUCTIVE GAMMA RAY SPECTROMETRIC TECHNIQUES. DETERMINATIONS OF THE DISTRIBUTIONS OF U AND TH IN SAMPLES OF RELATED ROCKS WILL PROVIDE INFORMATION REGARDING THE PARTITIONING OF THESE ELEMENTS DURING SOLIDIFICATION OF ROCK MELTS. THESE ELEMENTS TEND TO REMAIN IN SOLUTION UNTIL THE TERMINAL STAGES OF SOLIDIFICATION OF ROCK MELTS AND THEIR CONCENTRATIONS IN SUB-UNITS IN A ROCK COMPLEX CAN BE CORRELATED WITH OTHER INDICATORS OF AGE TO AID IN UNDERSTANDING THE CHEMICAL PROCESSES WHICH TAKE PLACE DURING SOLIDIFICATION.

RTOP NO. 185-50-71 TITLE: PLANETOLOGY STUDIES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BURCHAM, D. P. TEL. 213-354-3028

TECHNICAL SUMMARY

A PROGRAM OF THEORETICAL AND EXPERIMENTAL PLANETOLOGY WILL BE CONDUCTED WITH THE FOLLOWING GOALS: 1) UNDERSTANDING THE BASIC ATMOSPHERIC, SURFACE, AND SUBSURFACE GEOLOGICAL PROPERTIES OF THE TERRESTRIAL PLANETS, 2) APPLYING OF THESE FINDINGS TOWARD THE DESIGN OF EXPERIMENTS AND THE INTERPRETATION OF DATA FROM EXPERIMENTS ON UNMANNED ORBITING AND LANDED SPACECRAFT AND, 3) DETERMINING THE EVOLUTIONARY HISTORY OF PLANETS AND THE SOLAR SYSTEM. THIS PROGRAM CONTRIBUTES TO THE PLANETARY MISSIONS IN THREE WAYS: 1) THE RESEARCH TOPICS ARE DIRECTLY RELEVANT TO PLANETARY SCIENCE, 2) THE PROGRAM RETAINS WITHIN JPL A STAFF OF SPECIALISTS WHO CONTRIBUTE TO THE DEFINITION OF SCIENTIFIC OBJECTIVES AND RATIONALE FOR PLANETARY MISSIONS, AND 3) ANALYTICAL INSTRUMENTS BEING DEVELOPED CAN BE USED FOR SURFACE MEASUREMENTS ON PLANETS BY FUTURE UNMANNED MISSIONS. THE STUDIES TO BE CONDUCTED IN FY'71 PERTAIN TO: 1. PHOTOGEOLOGY OF PLANETARY SURFACES. 2. DEVELOPMENT OF A COMBINED ALPHA-SCATTERING/X-RAY INSTRUMENT. THE ALPHA-SCATTERING/X-RAY FLUORESCENCE INSTRUMENT IS TO BE DEVELOPED FOR MARS LANDER OPPORTUNITIES. THE SPECIFIC OBJECTIVES FOR THE YEAR ARE TO ASSIST THE UNIVERSITY OF CHICAGO IN DESIGN OF SUCH AN INSTRUMENT, STUDY THE INTERACTION OF CHARGED PARTICLES WITH MATTER USING THE CALTECH TANDEM ACCELERATOR, AND DETERMINE THE FEASIBILITY OF ADDING AN X-RAY MODE OF ANALYSIS TO THE ALPHA-SCATTERING INSTRUMENT.

RTOP NO. 185-50-81 TITLE: PLANETARY GEOSCIENCE STUDIES

ORGANIZATION: NASA HEADQUARTERS

MONITOR: DWORNIK, S. E. TEL. 202-962-1151

TECHNICAL SUMMARY

THE OBJECTIVE OF GEOSCIENCE RESEARCH IS THE STUDY OF THE SURFACE AND INTERIOR OF PLANETS TO UNDERSTAND THEIR ORIGIN, EVOLUTION AND COMPOSITION.

RTOP NO. 185-90-01 TITLE: INSTITUTIONAL SUPPORT
ORGANIZATION: GODDARD INSTITUTE FOR SPACE STUDIES
MONITOR: ABID, G. E. TEL. 301-982-4551
TECHNICAL SUMMARY

THE GODDARD INSTITUTE FOR SPACE STUDIES IS CHARGED WITH THE CONDUCT OF THEORETICAL RESEARCH IN METEOROLOGY, GEOPHYSICS, AND ASTRONOMY WITH EMPHASIS ON ATMOSPHERIC DYNAMICS & CONVECTION. HISTORICALLY THE INSTITUTE'S CIVIL SERVICE STAFF HAS BEEN AUGMENTED BY RESOURCES OF THE COMMERCIAL SEGMENT OF THE ECONOMY TO PROVIDE NECESSARY SUPPORT FUNCTIONS. THE INSTITUTE'S PROGRAM INCLUDES BASIC STUDIES IN THEORIES OF TURBULENCE, CONVECTION & RADIATIVE TRANSFER. THE INSTITUTE PROVIDES A WORKING LIAISON BETWEEN NASA AND THE ACADEMIC COMMUNITY BY CARRYING OUT ITS PROGRAMS IN CLOSE ASSOCIATION WITH UNIVERSITIES IN THE NEW YORK METROPOLITAN AREA IN ORDER TO STIMULATE THE INTEREST OF FACULTY MEMBERS AND STUDENTS IN THE AREA OF RESEARCH RELEVANT TO THE NASA PROGRAM. THE INSTITUTE ASSISTS IN THE ANALYSIS AND INTERPRETATION OF DATA GATHERED BY SCIENTIFIC SATELLITES AND PROVIDES GENERAL ASSISTANCE AND SUPPORT TO GODDARD AND NASA HEADQUARTERS IN SPACE SCIENCES ACTIVITIES.

RTOP NO. 185-90-02 TITLE: NATIONAL SPACE SCIENCE DATA CENTER
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: VETTE, J. I. TEL. 301-982-2354
TECHNICAL SUMMARY

A) THE NATIONAL SPACE SCIENCE DATA CENTER (NSSDC) WAS ESTABLISHED TO FURTHER THE WIDEST PRACTICABLE USE OF REDUCED DATA OBTAINED FROM SPACE SCIENCE INVESTIGATIONS AND TO PROVIDE INVESTIGATORS WITH AN ACTIVE REPOSITORY FOR SUCH DATA. AS SUCH, IT IS RESPONSIBLE FOR THE ACTIVE COLLECTION, ORGANIZATION, STORAGE, ANNOUNCEMENT, RETRIEVAL, DISSEMINATION, AND EXCHANGE OF DATA RECEIVED FROM SATELLITE EXPERIMENTS, SOUNDING-ROCKET PROBES, AND HIGH-ALTITUDE AERONAUTICAL AND BALLOON INVESTIGATIONS. IN ADDITION, THE DATA CENTER COLLECTS CORRELATIVE DATA, SUCH AS MAGNETOGRAMS AND IONOGRAMS, FROM GROUND-BASED OBSERVATORIES AND STATIONS FOR NASA INVESTIGATORS AND FOR ONSITE USE AT NSSDC IN THE ANALYSIS AND EVALUATION OF SPACE SCIENCE EXPERIMENTAL RESULTS. B) THE DATA CENTER PROVIDES DUPLICATE COPIES OF REDUCED EXPERIMENTAL DATA ON REQUEST. WITHIN THE CAPABILITIES OF NSSDC, THE DATA MAY BE CONVERTED TO ANOTHER MEDIUM TO MEET THE NEEDS OF THE REQUESTER.

RTOP NO. 186-68-50 TITLE: ADVANCED SYSTEM TECHNOLOGY/THERMOELECTRIC
OUTER PLANET SPACECRAFT
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: SHIPLEY, W. S. TEL. 213-354-4450
TECHNICAL SUMMARY

THE OBJECTIVES OF THE THERMOELECTRIC OUTER PLANET SPACECRAFT (TOPS) PROJECT ARE TO PERFORM DESIGN AND DEVELOPMENTAL TESTING OF AN

OUTER PLANET SPACECRAFT SYSTEM, AND SELECTED SUBSYSTEMS AND SUBASSEMBLIES USING TECHNOLOGIES CRITICAL TO THE GRAND-TOUR TYPE MISSION. THE INTERACTIONS OF THE SUBSYSTEMS (SCIENCE AND ENGINEERING) IN THE INTEGRATED SYSTEM CONSIDERING THE SIGNIFICANT AND NEW ENVIRONMENTS WILL BE EVALUATED SO THAT REALISTIC PERFORMANCE, TESTING AND RELIABILITY FOR LONG-LIFE CAN BE ASSESSED AND ASSOCIATED COST ESTIMATES CAN BE MADE. ADVANCED SYSTEM TECHNOLOGY WILL BE USED IN SYSTEM AND DETAILED DESIGN OF THE SPACECRAFT AND DEVELOPMENTAL TESTING WILL BE PERFORMED ON SELECTED HARDWARE. NEW ENVIRONMENTAL DESIGN RESTRAINTS AND TEST REQUIREMENTS WILL BE ESTABLISHED FOR THE SPACECRAFT SYSTEM AND SUBSYSTEMS AND TECHNIQUES FOR CONDUCTING TESTING IN THE NEW ENVIRONMENTS WILL BE EVALUATED. PRELIMINARY EVALUATION OF TEST AND OPERATIONS PLANS INCLUDING NUCLEAR OPERATIONS WILL BE PERFORMED. THE APPROACH WILL BE TO DESIGN A COMPLETE SPACECRAFT, FABRICATE ELEMENTS OF SELECTED SUBSYSTEMS AND INTEGRATE SELECTED BREADBOARD ELEMENTS FOR FUNCTIONAL SIMULATION TO EXPLORE FEASIBILITY OF DESIGN AND COMPATIBILITY. MISSION OBJECTIVES HAVE BEEN DEFINED AND A MISSION MODE HAS BEEN SELECTED. SYSTEM AND SUBSYSTEM DESIGN AND CONCEPTUAL SPACECRAFT CONFIGURATION DESIGN HAS PROVIDED MAJOR FUNCTIONAL REQUIREMENTS WHICH HAVE BEEN INTEGRATED IN THE SYSTEM. SYSTEM/SUBSYSTEM INTERFACES AND DESIGN TRADE-OFFS ARE BEING EVALUATED. A DOCUMENT STATING THE PROJECT POLICIES AND REQUIREMENTS HAS BEEN WRITTEN AND ISSUED. ESTIMATES AND DESIGN RESTRAINTS FOR THE SPACECRAFT'S ENVIRONMENT THROUGHOUT THE MISSION HAVE BEEN COMPILED. A SYSTEMS DESIGN REVIEW HAS BEEN COMPLETED AND CONTINUED EFFORT WILL BE PLACED ON SUBSYSTEM DESIGN AND RELIABILITY. SPECIAL COMMITTEES ON MICROELECTRONIC PARTS, NUCLEAR SAFETY AND OPERATIONS AND RADIATION TESTING ARE STUDYING PERTINENT PROBLEMS TO PROVIDE COORDINATED DIRECTION TO TOPS PROJECT.

RTOP NO. 186-68-51 TITLE: HEAT SHIELD EVALUATION FOR JUPITER PROBE MISSIONS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-1111

TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP THE HEAT-PROTECTION TECHNOLOGY SO THAT HEAT-PROTECTION SYSTEMS FOR UNMANNED PROBES ENTERING THE ATMOSPHERE OF JUPITER CAN BE DESIGNED WITH A MINIMUM WEIGHT, THUS, MAXIMIZING THE SCIENTIFIC PAYLOAD CAPABILITY. CANDIDATE HEAT SHIELD MATERIALS WILL BE SELECTED, SCREENED, AND TESTED UNDER CONDITIONS THAT SIMULATE THE HIGH HEATING RATES TYPICAL OF THOSE TO BE EXPECTED AT JOVIAN ENTRY VELOCITIES OF 50 KM/SEC. THE TESTS WILL BE CONDUCTED IN ELECTRIC-ARC-HEATED STREAMS AND HIGH-INTENSITY ARGON ARC AND LASER RADIATION FLUXES BOTH SINGLY AND IN COMBINATION. THE DEVELOPMENT OF A PULSED CONSTRICTED-ARC FACILITY CAPABLE OF DUPLICATING JUPITER ENTRY HEATING CONDITIONS WILL CONTINUE. THIS TECHNOLOGY IS REQUIRED TO PERMIT THE DESIGN OF HEAT PROTECTION SYSTEMS FOR UNMANNED PROBES ENTERING PLANETARY ATMOSPHERES AT VELOCITIES OF 50 KM/SEC.

RTOP NO. 186-68-52 TITLE: SCIENCE SUBSYSTEM TECHNOLOGY FOR OUTER
PLANET MISSIONS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MCDONALD, R. R. TEL. 213-354-6186

TECHNICAL SUMMARY

IN ORDER TO PREPARE FOR THE TECHNICALLY CHALLENGING MISSIONS TO THE OUTER PLANETS PLANNED FOR THE LATE 1970'S, IT IS NECESSARY TO GET AN EARLY START ON THE SOLUTION OF THE ANTICIPATED DIFFICULT OUTER PLANETS SCIENCE SYSTEMS PROBLEMS. AMONG THE OUTSTANDING PROBLEMS ARE; 1) TO DEFINE IMAGING EXPERIMENTS AND IMAGING SYSTEM FUNCTIONAL REQUIREMENTS FOR THESE MISSIONS IN ORDER TO ENSURE THAT A SUITABLE IMAGING SYSTEM WILL BE DEVELOPED IN TIME FOR SUCH MISSIONS AND 2) TO PRESERVE THE INTEGRITY OF THE SCIENTIFIC MEASUREMENTS BY DEVELOPING PROPER SHIELDING DESIGN TO PROTECT THEM FROM ENERGETIC RADIATIONS FROM ON-BOARD RTGS AND RADIATION SOURCES SUCH AS THE INTENSE JOVIAN RADIATION BELTS. BY MEANS OF IN-HOUSE STUDIES AND CONTACTS WITH OUTSIDE SCIENTISTS, IMAGING SCIENCE OBJECTIVE WILL BE GENERATED, AND KEPT CURRENT. THESE WILL BE USED TO DERIVE OUTER PLANETS IMAGING SYSTEM FUNCTIONAL REQUIREMENTS AND TO DEVELOP BASELINE IMAGING SYSTEM DESIGNS. NEW IMAGING SENSORS WILL BE EVALUATED FOR APPLICABILITY IN THE IMAGE SYSTEM DESIGN. IN ADDITION, TYPICAL OUTER PLANETS SCIENCE INSTRUMENTATION WILL BE STUDIED, ANALYTICALLY AND EXPERIMENTALLY, TO DETERMINE TOLERABLE RADIATION LEVELS AND SHIELDING DESIGNS WILL BE DEVELOPED AND TESTED TO ENSURE THAT BACKGROUND INSTRUMENTAL RADIATION EFFECTS ARE KEPT WITHIN TOLERANCE.

RTOP NO. 186-68-53 TITLE: TELECOMMUNICATIONS TECHNOLOGY FOR OUTER
PLANET MISSIONS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MCDONALD, R. R. TEL. 213-354-6186

TECHNICAL SUMMARY

THE PURPOSE OF THIS ACTIVITY IS THE DEVELOPMENT OF THE TELECOMMUNICATIONS TECHNOLOGY NECESSARY TO PERFORM MISSIONS TO THE OUTER PLANETS IN A RELIABLE AND COST-EFFECTIVE MANNER. THE COMMUNICATION RANGE FOR OUTER PLANET MISSIONS INCREASES FROM ABOUT 1 AU FOR MARS UP TO 31 AU FOR NEPTUNE. THUS, AN INCREASE OF AT LEAST 30 DB IS REQUIRED IN TELEMETRY AND COMMAND PERFORMANCE CAPABILITY TO EVEN KEEP UP WITH THE RATES OF THE MARINER '69 MISSION. FURTHERMORE, THE MISSION DURATION INCREASES FROM LESS THAN 1 YEAR FOR A MARS ORBITER UP TO 11 YEARS FOR A GRAND TOUR. YET, AS WITH ALL SPACECRAFT EQUIPMENT, THE OPERATING LIFE OF THE TELECOMMUNICATION SYSTEM MUST BE INCREASED ACCORDINGLY. DURING FY'71, THE WORK WILL CONTINUE AS A VITAL PART OF THE TOPS (THERMOELECTRIC OUTER PLANET SPACECRAFT) PROJECT. THE REQUIRED IMPROVEMENTS ARE BEING DEVELOPED BY BOTH IN-HOUSE AND CONTRACTED THEORETICAL AND EXPERIMENTAL EFFORTS. FIRST, DEVELOPMENT OF A LARGE UNFURLABLE ANTENNA PROVIDES INCREASED GAIN AND SMALLER ANTENNA POINTING ERROR LOSSES. SECOND, AN EFFICIENT X-BAND DATA-DUMP TELEMETRY SYSTEM INCLUDING SPACECRAFT ANTENNA FEEDS, TRANSMITTER, AND MODULATOR IS BEING DEVELOPED. THIRD, A SPACECRAFT COMMAND SYSTEM IS BEING DEVELOPED THAT IS MORE EFFICIENT IN THE COMMUNICATION THEORETIC SENSE. FOURTH, TO IMPROVE EQUIPMENT OPERATING LIFE AND STABILITY, COMMUNICATION EQUIPMENT IS BEING

DESIGNED TO UTILIZE DIGITAL CIRCUITS AS MUCH AS POSSIBLE, MICROWAVE POWER TUBES ARE BEING LIFE TESTED, AND REDUNDANT MECHANIZATIONS WILL BE SYNTHESIZED AND ANALYZED. FIFTH, OVERALL TELECOMMUNICATION SYSTEMS REQUIREMENTS ARE BEING ANALYZED TO OPTIMIZE TRACKING ACCURACY, TELEMETRY DATA RATES, COMMAND DATA RATES, AND OVERALL SYSTEMS RELIABILITY, COST, AND OPERATIONAL SIMPLICITY. SEVERAL KEY COMPONENTS FOR THIS RTOP ARE PROVIDED BY AN OART EFFORT, "MICROWAVE DEEP SPACE COMMUNICATION AND TRACKING", RTOP NO. 125-21-09.

RTOP NO. 186-68-53 TITLE: TELECOMMUNICATIONS TECHNOLOGY FOR OUTER PLANET PROBES

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: FOSTER, J. V. TEL. 415-961-1111

TECHNICAL SUMMARY

DATA FROM NASA'S MARINER V AND THE USSR'S VENERA-4, -5, AND -6 SHOW THAT SPECIAL SIGNAL LOSSES DEVELOP IN TRANSMISSION THROUGH DENSE PLANETARY ATMOSPHERES THAT WILL AFFECT THE DESIGN OF DATA LINKS FOR PROBES TO THE OUTER PLANETS. IN ORDER TO REDUCE SPACECRAFT COMMUNICATION DESIGN UNCERTAINTIES TO THE POINT OF REASONABLY ASSURED MISSION RELIABILITY IN JUPITER AND OTHER COMPLEX ATMOSPHERE ENVIRONMENTS, THE FOLLOWING PROPAGATION STUDIES WILL BE PURSUED: A. RECOMMENDATIONS FOR PROPAGATION EXPERIMENTS, TO BE CARRIED BY A SMALL PRECURSOR SPACECRAFT, TO FURTHER REVEAL JUPITER PROPAGATION CHARACTERISTICS. B. TURBULENCE FADING FLUCTUATIONS OF SIGNAL WITHIN THE JUPITER ATMOSPHERE, AND THE CAPABILITY OF JUPITER NOISE TO SELF-IONIZE THE JUPITER ATMOSPHERE. C. PROBABLE DEGREE OF SIGNAL ABSORPTION BY ATMOSPHERIC METHANE AND DEUTERATED AMMONIA. D. IMPLICATIONS OF SOLAR WIND BOW SHOCK WAVES IN AFFECTING COMMUNICATIONS IN THE JUPITER VICINITY, AND CAPABILITY OF TRAPPED ELECTRONS BETWEEN RADIATION FIELDS FOR AFFECTING SPACECRAFT ANTENNA TEMPERATURES AND DEPOLARIZING SIGNALS. E. ADDITIONAL DEDUCTIONS THAT CAN BE MADE FROM JUPITER VICINITY RADIO TRANSMISSIONS RECEIVED AT EARTH TRACKING STATIONS, TO FURTHER REVEAL JUPITER PROPAGATION PARAMETERS. F. EXTENSIONS OF FINDINGS TO THE RELATED ENVIRONMENTS OF THE OTHER OUTER PLANETS.

RTOP NO. 186-68-54 TITLE: GUIDANCE AND CONTROL TECHNOLOGY FOR OUTER PLANET MISSIONS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MCDONALD, R. R. TEL. 213-354-6186

TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THIS PROGRAM IS TO PROVIDE GUIDANCE AND CONTROL TECHNOLOGY FOR FUTURE LONG TERM MISSIONS TO THE OUTER PLANETS. THESE MISSIONS ARE TYPIFIED BY THE PROPOSED GRAND TOUR MISSION: A FLIGHT TIME OF 8-12 YEARS WITH FLYBYS OF SEVERAL PLANETS.

AS SUCH, THE PROGRAM IS A LONG TERM, CONTINUING EFFORT TO PROVIDE THE HARDWARE AND ANALYSIS NEEDED TO SUPPORT THE REQUIREMENTS OF THE THERMOELECTRIC OUTER PLANET SPACECRAFT (TOPS) PROJECT. THE REQUIREMENTS GENERATED BY TOPS ARE THREEFOLD: INCREASED ACCURACY IN THE ATTITUDE CONTROL AREA; DEVELOPMENT OF AN OUTER PLANET APPROACH

GUIDANCE SYSTEM; AND THE REALIZATION OF A MUCH HIGHER LEVEL OF RELIABILITY THAN REQUIRED FOR PREVIOUS MISSIONS. THE INCREASED ATTITUDE CONTROL ACCURACY REQUIRES A COMPLETELY DIFFERENT SYSTEM THAN USED PREVIOUSLY WHILE THE AG SYSTEM IS COMPLETELY NEW. THEREFORE, THE PRIMARY EFFORT WILL BE TO DEVELOP FEASIBLE CONCEPT AND WHERE POSSIBLE, DEMONSTRATE THESE CONCEPTS. CONTINUED SUPPORT WILL BE GIVEN TO THE TOPS DESIGN TEAM AS REQUIRED. THE GENERAL AREAS TO BE COVERED WILL BE SPACECRAFT ATTITUDE CONTROL, THE APPROACH GUIDANCE SYSTEM AND THE ASSOCIATED GROUND SUPPORT EQUIPMENT (GSE). DURING FY'71, THE WORK WILL BE A CONTINUATION OF THE APPROACHES DEVELOPED DURING FY'70: DEMONSTRATING THE CHARACTERISTICS OF THE BASELINE SYSTEMS. IN THE SPACECRAFT ATTITUDE CONTROL AREA, A SINGLE AXIS ATTITUDE CONTROL SIMULATION WILL BE MADE USING DEVELOPMENT HARDWARE AND AN AIR BEARING TABLE. BOTH STUDIES AND HARDWARE DEMONSTRATION WILL BE MADE TO PROVIDE REDUNDANCY. FOR APPROACH GUIDANCE, DATA PROCESSING STUDIES WILL CONTINUE, AND USING THE ESTABLISHED REQUIREMENTS DESIGN OF A TV APPROACH GUIDANCE SENSOR WILL START. THE GROUND SUPPORT EQUIPMENT TASK WILL MONITOR THE INTERFACES BETWEEN ATTITUDE CONTROL, APPROACH GUIDANCE AND THE CENTRAL PROCESSOR, WITH PARTICULAR ATTENTION TO DEVELOPMENT OF AUTOMATED CHECKOUT TECHNIQUES.

RTOP NO. 186-68-55 TITLE: GUIDANCE & CONTROL TECHNOLOGY FOR MARS
ROVING VEHICLES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MCDONALD, R. R. TEL. 213-354-6186

TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THIS PROGRAM IS TO PROMOTE THE CAPABILITY FOR DEVELOPING CONCEPTS, SUBSYSTEMS AND COMPONENTS FOR CONTROLLING THE MOTION OF UNMANNED PLANETARY SURFACE ROVING VEHICLES, WHICH PROVIDE AN EXTENSIVE SCIENTIFIC EXPLORATIONAL CAPABILITY. THIS PROGRAM IS A LONG-TERM RESEARCH AND ADVANCED DEVELOPMENT EFFORT TO PERFORM THE ANALYSES, SIMULATIONS AND HARDWARE DEVELOPMENT NECESSARY FOR PLANETARY ROVING VEHICLE MISSIONS. THE IN-HOUSE EFFORT IN FY71 WILL BE EXPENDED ON MONITORING THE TECHNICAL PROGRESS OF RESEARCH CONTRACTS AT CORNELL UNIVERSITY AND RENSSELAER POLYTECHNIC INSTITUTE AND CONTRACTED FOR BY NASA HEADQUARTERS. THE RESEARCH CONTRACTS AT BOTH UNIVERSITIES STRONGLY EMPHASIZE THE ANALYSIS AND DEVELOPMENT OF SUBSYSTEMS AND COMPONENTS FOR AN UNMANNED MARS ROVING VEHICLE. REVIEW MEETINGS WITH THE RESEARCH PARTICIPANTS WILL BE HELD AT EACH UNIVERSITY ON APPROXIMATELY SIX TO EIGHT WEEK INTERVALS. THESE MEETINGS WILL SERVE TO EVALUATE THEIR TECHNICAL PERFORMANCE AND PROVIDE TECHNICAL DIRECTION TO THEIR ACTIVITIES. THE TECHNICAL MONITOR, IN ADDITION, WILL ASSURE THAT AN EXCHANGE OF INFORMATION TAKES PLACE BETWEEN THE PARTICIPANTS AND OTHERS, INCLUDING NASA CENTERS, OTHER UNIVERSITIES AND INDUSTRY, WHERE RELATED WORK IS IN PROGRESS. THE BENEFITS DERIVED FROM THESE CONTRACTS ARE TWOFOLD. FIRST, THE RESULTS ARE USEFUL IN MAINTAINING AND IMPROVING THE CAPABILITY OF JPL AND NASA TO DEVELOP AN UNMANNED ROVING VEHICLE FOR PLANETARY EXPLORATION. AND SECOND, THE STUDENT PARTICIPANTS ARE CONFRONTED WITH A PRACTICAL ENGINEERING PROBLEM DURING THEIR COURSE OF STUDY. THIS SIGNIFICANTLY INCREASES THE STUDENT'S ABILITY TO COPE WITH ENGINEERING PROBLEMS UPON HIS GRADUATION.

RTOP NO. 186-68-55 TITLE: MARS ROVING VEHICLE TECHNOLOGY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: TARVER, P. TEL. 202-963-6985
TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THIS PROGRAM IS TO PROMOTE THE CAPABILITY FOR DEVELOPING CONCEPTS, SUBSYSTEMS AND COMPONENTS FOR CONTROLLING THE MOTION OF UNMANNED PLANETARY SURFACE ROVING VEHICLES. THE PROGRAM IS A LONG-TERM RESEARCH AND ADVANCED DEVELOPMENT EFFORT AND WILL INCLUDE ANALYSES, SIMULATIONS AND HARDWARE DEVELOPMENT FOR MARS ROVING VEHICLE MISSIONS. THE EFFORT IN FY '71 WILL SUPPORT RESEARCH CONTRACTS AT CORNELL UNIVERSITY AND RENSSELAER POLYTECHNIC INSTITUTE. THE BENEFITS DERIVED FROM THESE CONTRACTS ARE TWOFOLD. FIRST, THE RESULTS ARE USEFUL IN MAINTAINING AND IMPROVING THE CAPABILITY OF NASA TO DEVELOP AN UNMANNED ROVING VEHICLE FOR PLANETARY EXPLORATION. AND SECOND, THE STUDENT PARTICIPANTS ARE CONFRONTED WITH A PRACTICAL ENGINEERING PROBLEM DURING THEIR COURSE OF STUDY. THIS SIGNIFICANTLY INCREASES THE STUDENT'S ABILITY TO COPE WITH ENGINEERING PROBLEMS UPON HIS GRADUATION.

RTOP NO. 186-68-56 TITLE: CENTRAL DATA SUBSYSTEM FOR OUTER-PLANET MISSIONS

ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

THE OBJECTIVE OF THE RTOP IS TO DEVELOP ADVANCED S/C DATA SYSTEMS FOR UNMANNED DEEP SPACE MISSIONS. RESULTS WILL BE IN THE FORM OF DESIGNS, BREADBOARDS, OR PROTOTYPES. THIS WILL BE ACCOMPLISHED THRU IN-HOUSE DESIGN COMPLEMENTED BY DEVICE AND SUBSYSTEM DEVELOPMENT CONTRACTS. THE FY'70 & '71 EFFORTS ARE EXCLUSIVELY IN SUPPORT OF THE ADVANCED SYSTEM TECHNOLOGY (AST) THERMOELECTRIC OUTER PLANET S/C (TOPS) CENTRAL DATA SYSTEM (CDS). THE FY'72 EFFORT WILL SUPPORT THE NASA OUTER PLANET PROGRAM DEPENDENT UPON THE FORMAL STATUS OF OUTER PLANET PROJECTS. THE RESULTS WILL BE APPLICABLE TO OTHER POST-1975 PROJECTS WITH SEVERE RELIABILITY REQUIREMENTS. THE CDS INCLUDES THOSE DATA SUBSYSTEMS WHICH PERFORM THE FUNCTION OF CONTROL, MEASUREMENT, AND STORAGE. "CONTROL" INCLUDES THE GENERATION & DISTRIBUTION OF TIMING SIGNALS, SEQUENCING THE S/C THRU ITS DESIRED STATES (MODES), PERFORMING MAINTENANCE AND FAILURE DIAGNOSTICS ON OTHER S/C SUBSYSTEMS, AND SWITCHING IN REDUNDANT UNITS OR PERFORMING THE EQUIVALENT FUNCTIONS. "MEASUREMENT" CONSISTS OF CONDITIONING, SAMPLING, ENCODING, MULTIPLEXING, COMPRESSING, AND FORMATTING DATA FOR TRANSMISSION OR STORAGE. "STORAGE" INCLUDES MASS STORAGE (TAPE RECORDERS) BUFFER STORAGE (EITHER MAGNETICS OR SEMICONDUCTORS), AND WORKING STORAGE (READ-WRITE OR READ-ONLY MEMORIES). THE CDS IS CONSIDERABLY MORE CENTRALIZED THAN ITS MARINER-CLASS PREDECESSORS AS A DIRECT CONSEQUENCE OF THE NEED FOR GREATLY INCREASED RELIABILITY AND ON-BOARD DECISION-MAKING. CENTRALIZATION PROVIDES FOR INCREASED COMPUTATIONAL CAPABILITY AND MORE EFFICIENT ALLOCATION OF REDUNDANCY. DURING FY'71 THE DETAILED FUNCTIONAL DESIGN OF MOST OF THE CDS WILL BE COMPLETED. THE MEASUREMENT PROCESSOR WILL BE BREADBOARDED AND TESTED WITH SIMULATED MEASUREMENT INPUTS; IT WILL THEN BE MATED WITH

THE STAR (SELF-TEST & REPAIR) COMPUTER BREADBOARD WHICH WILL SIMULATE THE CDS CENTRAL COMPUTER (CC).

RTOP NO. 186-68-57 TITLE: ENGINEERING MECHANICS TECHNOLOGY FOR
OUTER PLANET MISSIONS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MCDONALD, R. R. TEL. 213-354-6186

TECHNICAL SUMMARY

MAJOR CHARACTERISTICS OF ADVANCED OUTER PLANET SPACECRAFT INCLUDE: INCREASED COMMUNICATION CAPABILITIES, RTG POWER SOURCES, NEW PROPELLANTS, EXTREME LOW TEMPERATURE ENVIRONMENTS AND VERY LONG LIFE. THIS RTOP CONSISTS OF A NUMBER OF TASKS HAVING AS THEIR COMMON GOAL THE IDENTIFICATION OF NEW ENGINEERING MECHANICS REQUIREMENTS OF SUCH SPACECRAFT AND THE DEVELOPMENT OF THE TECHNOLOGIES NEEDED TO SATISFY THEM. TO PROVIDE THE REQUIRED DATA RATE, THE TOPS SPACECRAFT USES A 14-FOOT DIAMETER DEPLOYABLE X-BAND ANTENNA. THIS RTOP, IN COOPERATION WITH THE TELECOMMUNICATIONS DIVISION RTOP 186-68-53, WILL ACCOMPLISH THE IN-HOUSE DEVELOPMENT OF THAT ANTENNA. ANALYSIS, DESIGN, AND MATERIALS EVALUATION ARE IN PROGRESS. THE TASK WILL BE COMPLETED IN THE FIRST HALF OF FY'72. THIS RTOP WILL PROVIDE GENERAL MECHANICAL SUPPORT TO THE TOPS PROJECT. A FULL-SCALE MODEL (MOCK-UP) OF THE SPACECRAFT IS BEING CONSTRUCTED AND WILL BE UPGRADED IN FY'71 TO SERVE AS A RADIATION TEST MODEL (RTM). PROTOTYPE ACTUATOR/DAMPERS FOR THE RTG AND SCIENCE BOOMS ARE BEING DEVELOPED. RELIABILITY ASPECTS OF A LONG-LIFE PUMP (FOR USE IN THE FLUID LOOP HEAT TRANSPORT SYSTEM) AND THE DEPLOYABLE MAGNETOMETER BOOMS WILL BE INVESTIGATED IN FY'71. A COMPUTER CODE HAS BEEN SELECTED AND WILL BE USED IN FY'71 TO PERFORM THE REFINED CALCULATIONS NECESSARY TO PRODUCE REASONABLY ACCURATE MAPS OF THE NEUTRON AND GAMMA RADIATION FIELDS RESULTING FROM THE RTG POWER SOURCE ON THE TOPS SPACECRAFT. POLYMERIC ADHESIVE SYSTEMS SUITABLE FOR HIGH AND LOW TEMPERATURE EXTREMES AND LONG-LIFE REQUIREMENTS WILL BE ESTABLISHED. CANDIDATES HAVE BEEN SELECTED AND WILL BE EXPOSED TO PLUS 500 DEGREES F FOR 4000 HOURS IN FY'71. SURVIVORS SHOULD ALSO BE GOOD CANDIDATES FOR SURVIVAL OF LONG TERM TESTS AT MINUS 375 DEGREES F IN FY'72.

RTOP NO. 186-68-58 TITLE: PACKAGING AND CABLING TECHNOLOGY

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MCDONALD, R. R. TEL. 213-354-6186

TECHNICAL SUMMARY

INCREASINGLY COMPLEX SPACE MISSIONS HAVE REQUIREMENTS FOR LONGER LIFE AND IMPROVED PACKAGING EFFICIENCY. THEY ARE REQUIRING GREATER RELIABILITY TO OPERATE IN INCREASINGLY SEVERE ENVIRONMENTS. THIS CREATES A PARADOX FOR PACKAGING IN THAT A LARGER NUMBER OF SMALLER AND MORE FRAGILE COMPONENTS MUST BE ASSEMBLED AND INTERCONNECTED TO PERFORM RELIABLY FOR A LONGER TIME. ELECTRONIC PACKAGING AND CABLING IS THE APPLICATION OF BASIC PHYSICAL PRINCIPLES IN TRANSFORMING ELECTRONIC SCHEMATICS AND COMPONENTS INTO EQUIPMENT CAPABLE OF PERFORMING ITS ELECTRICAL DESIGN FUNCTION. IT IS THE APPLICATION OF ENGINEERING METHODS AND TECHNIQUES USING BASIC PHYSICAL LAWS TO

MECHANICAL DESIGN, FABRICATION, INTERCONNECTION, AND INTEGRATION TO ASSURE OPERATION OF ELECTRONIC EQUIPMENT IN SPECIFIED ENVIRONMENTS. THIS EQUIPMENT PERFORMANCE MUST BE PREDICTABLE AND CANNOT BE DEGRADED BY ENVIRONMENTAL STRESSES IMPOSED BY FABRICATION, INSPECTION, TEST, REPAIR, EARTH ATMOSPHERE, LAUNCH, SPACE AND TIME. THE GOAL IS TO SYNTHESIZE BOTH EXISTING AND DEVELOPED PACKAGING AND CABLING TECHNOLOGIES AND PERFORM SUCH DEVELOPMENTS NECESSARY TO PROVIDE A PROVEN SYSTEM COVERING THE FUNCTIONS OF PACKAGING AND CABLING. BY PERFORMING THIS WORK WITHOUT FLIGHT PROJECT SCHEDULES AND CONSTRAINT A MORE SEARCHING REVIEW AND ANALYSIS OF PROBLEMS CAN BE MADE. SOLUTIONS CAN BE DEVELOPED, TESTED, EVALUATED AND DOCUMENTED IN A FORM TO PROVIDE SIGNIFICANT ADVANTAGE IN OBTAINING LONG LIFE RELIABLE MISSION PERFORMANCE. THE APPROACH IS TO REVIEW EXISTING AND PROPOSED JPL AND OTHER PACKAGING AND CABLING METHODS AND TECHNIQUES. THROUGH EVALUATION AND ANALYSIS CHOOSE APPROPRIATE TECHNOLOGIES FOR FURTHER DEVELOPMENT AND INTEGRATION INTO A PACKAGING SYSTEM. BY DEVELOPING THE CONCEPTS AND APPLYING THEM ON SYSTEM DEVELOPMENT PROJECTS, SIGNIFICANT DEVELOPMENTS CAN BE READY FOR A MISSION THAT COULD NOT OTHERWISE BE CONSIDERED. THIS WORK UNIT ALSO FURNISHES THE NONDEVELOPMENT BUT NECESSARY HOUSEKEEPING ACTIVITIES OF THE PACKAGING AND CABLING FUNCTIONS NECESSARY FOR THE TOPS PROJECT.

RTOP NO. 186-68-59 TITLE: JUPITER ATMOSPHERIC ENTRY PROBE
HIGH-SPEED BRAKING SURVIVAL ANALYSIS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

WE INTEND TO (1) COMPUTE THE EFFECT OF A JUPITER PROBE HIGH-SPEED SHOCK COMPRESSION ON THE THERMOCHEMISTRY AND RADIATION CHARACTERISTICS OF POSTULATED JUPITER ATMOSPHERIC GASES, AND (2) DETERMINE THE PROBABLE RESPONSE OF THE VEHICLE HEAT SHIELD AND THE THERMAL AND PRESSURE LOADINGS TO THE STRUCTURE. THIS WORK WILL BE DONE WITH EXISTING TRAJECTORY, THERMOCHEMISTRY, SPECTRAL INTENSITY, FLOW-FIELD, AND DYNAMIC MOTION COMPUTER PROGRAMS. THE WORK WILL SUPPORT ONGOING AND FUTURE JUPITER ATMOSPHERIC ENTRY PROBE SYSTEM STUDIES.

RTOP NO. 186-68-60 TITLE: LONG RANGE PLANNING STUDIES FOR SOLAR
SYSTEM EXPLORATION
ORGANIZATION: NASA HEADQUARTERS
MONITOR: TARVER, P. TEL. 202-963-6985
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO OBTAIN SCIENTIFIC AND TECHNICAL DATA AND TO EVALUATE OR DEVELOP METHODOLOGIES THAT WILL AID IN PLANNING FOR PLANETARY ADVANCED MISSIONS AND ADVANCED TECHNOLOGY. MISSION STUDIES TO BE CONDUCTED WILL TYPICALLY COVER SCIENCE OBJECTIVES, TRAJECTORY/PAYLOAD/LAUNCH VEHICLE ANALYSES AND REPRESENTATIVE SPACECRAFT CHARACTERISTICS AND TECHNOLOGY REQUIREMENTS. FOR FY 1971, PLANNED STUDIES ARE: (1) OUTER PLANET SATELLITE MISSION, (2) OUTER PLANET ENTRY PROBES, (3) COST

ESTIMATION TECHNIQUES, (4) SATURN RINGS MISSION, (5) VENUS LANDER MISSION, (6) COMPOSITE JUPITER GRAVITY ASSIST MISSIONS, (7) PLANETARY SCIENCE OBJECTIVES AND INSTRUMENTS, (8) COMET MISSIONS, (9) LAUNCH VEHICLE ALTERNATIVES. INDIVIDUAL STUDY REPORTS AND AN ANNUAL REPORT WILL BE ISSUED; WITH INTERIM REPORTS OR PRESENTATIONS AS APPROPRIATE.

RTOP NO. 186-68-60 TITLE: VENUS EXPLORATION TECHNOLOGY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: MARCOTTE, P. G. TEL. 301-982-4646
TECHNICAL SUMMARY

THE PURPOSE OF THIS RTOP IS TO: (1) CONTINUE DEVELOPMENT OF A HIGH-GAIN, NON-MAGNETIC ELECTRONICALLY DESPUN ANTENNA SYSTEM. (2) DEVELOP A LOW BIT RATE COMMUNICATION SYSTEM FOR PLANETARY SPACECRAFT WHEN THE SPACECRAFT DIRECTIONAL ANTENNA IS NOT POINTING DIRECTLY TO EARTH AND FOR USE AS THE PRIMARY MEANS OF COMMUNICATION FROM PLANETARY ENTRY PROBES. (3) TO ANALYZE AND EVALUATE VARIOUS SYSTEMS, SUBSYSTEMS AND SPACECRAFT OPERATIONS IN SUPPORT OF AN EXTENSIVE VENUS EXPLORATION PROGRAM PARTICULARLY WITH REGARD TO RELIABILITY AND BIO-CONTAMINATION. (4) OVER GUIDELINES - TO APPLY ADVANCED TECHNOLOGY, IN THE AREAS OF ELECTRONICALLY COMMUTATED D.C. TORQUERS, SERVO SPEED CONTROL AND UNIQUE BEARINGS, LUBRICANTS AND STRUCTURAL MATERIALS, TO DESIGN OF MECHANICAL DESPUN ANTENNA SUITABLE FOR LONG TERM (5 TO 10 YEARS) OPERATION IN PLANETARY EXPLORATION. (5) OVER GUIDELINES - TO DEVELOP A TECHNIQUE FOR DETERMINING THE MAGNETIC TORQUE FELT BY A SPACECRAFT ON THE BASIS OF NEAR FIELD MAGNETIC MEASUREMENTS. ALSO TO DETERMINE THE EFFECTIVE DIPOLE MOMENT OF A SPACECRAFT IN WHICH THE FAR FIELD IS TOO WEAK TO BE RELIABLY MEASURED.

RTOP NO. 186-70-51 TITLE: ELECTRONIC PARTS FOR OUTER PLANET MISSIONS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

OBJECTIVE: AN INTEGRATED EFFORT TO DEVELOP AND EVALUATE THE ELECTRONIC PARTS AND THE ASSOCIATED RELIABILITY AND QUALITY ASSURANCE TECHNIQUES NEEDED FOR THE OUTER PLANET MISSIONS. APPROACH: THE INITIAL ACTIVITIES WILL BE CONDUCTED IN SUPPORT OF THE THERMOELECTRIC OUTER PLANET SPACECRAFT (TOPS). EMPHASIS WILL BE PLACED ON THE DEVELOPMENT AND/OR EVALUATION OF MICROELECTRONIC DEVICES NEEDED FOR TOPS TYPE OUTER PLANET SPACECRAFT AND THE IMPLEMENTATION OF THE RELIABILITY AND QUALITY ASSURANCE PROGRAM DESCRIBED IN THE TOPS POLICY AND REQUIREMENTS DOCUMENT. THE IMPLEMENTATION OF THIS EFFORT WILL BE COORDINATED THROUGH THE ACTIVITIES OF THE TOPS MICROELECTRONICS COMMITTEE. THE PURPOSE OF THIS COMMITTEE IS TO DETERMINE THE VARIOUS NEEDS OF THE TOPS SUBSYSTEMS, FASTER STANDARDIZATION OF COMPONENTS THROUGHOUT THE SPACECRAFT SYSTEM, PURSUE DEVICE DEVELOPMENT WHERE SUBSYSTEM NEEDS DICTATE AND DEVELOP THE NECESSARY RELIABILITY AND QUALITY ASSURANCE TECHNIQUES FOR MICROELECTRONICS. IN THE AREA OF DISCRETE PARTS EMPHASIS WILL BE

PLACED ON THE PREPARATION OF A TOPS RECOMMENDED PARTS LIST FOR USE BY SUBSYSTEM DESIGNERS. THIS WILL INCLUDE RADIATION RESISTANCE, DERATING FACTORS AND SUITABILITY FOR LONG LIFE APPLICATIONS. DESIGN APPRAISAL INVESTIGATION OF APPROPRIATE COMPONENTS WILL BE CONDUCTED TO DEVELOP A BETTER UNDERSTANDING OF THE PROCESSES AND TECHNIQUES USED IN FABRICATING THESE COMPONENTS. RESULTS OF SUCH APPRAISALS WILL BE USED TO DETERMINE THEIR CAPABILITY FOR SUCCESSFUL OPERATION IN LONG LIFE MISSIONS. IN ADDITION EFFORT WILL BE EXPENDED TO DEVELOP RELIABILITY ANALYSIS AND PREDICTION TECHNIQUE PERFORM SUBSYSTEM RELIABILITY TRADEOFFS, ELECTRONIC PART FAILURE RATE COMPILATIONS AND A HARDWARE INSPECTION PROGRAM IN SUPPORT OF THE TOPS MICROELECTRONIC ACTIVITIES AND FEASIBILITY DEMONSTRATIONS.

RTOP NO. 188-36-51 TITLE: MAGNETODYNAMIC/MAGNETIC FIELDS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: KAVANAGH, L. D. TEL. 202-962-1987
TECHNICAL SUMMARY

THE OBJECTIVE IS TO INVESTIGATE BOTH STEADY AND FLUCTUATING MAGNETIC FIELDS IN THE EARTH'S MAGNETOSPHERE, IN INTERPLANETARY SPACE, AND IN THE VICINITY OF THE MOON AND PLANETS, AND TO USE THESE FIELDS AS INDICATORS OF LARGE AND SMALL SCALE DYNAMIC PROCESSES OCCURRING IN THESE REGIONS. DC AND SLOWLY-VARYING MAGNETIC FIELD MEASUREMENTS IN SPACE ARE USED TO DEFINE THE GEOMETRY OF THE MAGNETOSPHERE CAVITY AND MANY FEATURES OF THE MAGNETOSPHERE INCLUDING THE BOW SHOCK, MAGNETOPOUSE, AND TAIL REGION. IN THE INTERPLANETARY MEDIUM, THESE MEASUREMENTS ARE USED TO DEFINE SECTOR, FILAMENTARY AND OTHER STRUCTURE IN THE SOLAR WIND, WHICH CAN BE RELATED TO PROCESSES ON THE SOLAR SURFACE. ALSO, MAGNETIC FIELD MEASUREMENTS IN THE VICINITY OF THE MOON AND PLANETS ARE USED TO RELATE TO QUESTIONS SUCH AS THE EXISTENCE OF PLANETARY RADIATION BELTS AND DYNAMICAL PROCESSES IN PLANETARY INTERIORS. AC MAGNETIC FIELD INVESTIGATIONS IN SPACE ARE USED IN THE STUDY OF HYDROMAGNETIC WAVES, GEOMAGNETIC STORMS, PLASMA INSTABILITIES, PLASMA TURBULANCE, DIFFUSION OF TRAPPED PARTICLES, STRUCTURE OF THE BOW SHOCK, MAGNETOPOUSE, AND PLASMAPAUSE, AND A VARIETY OF OTHER APPLICATIONS.

RTOP NO. 188-36-52 TITLE: MAGNETODYNAMICS/ELECTRIC FIELDS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: KAVANAGH, L. D. TEL. 202-962-1987
TECHNICAL SUMMARY

THE OBJECTIVE IS TO STUDY BOTH AC AND DC ELECTRIC FIELDS IN THE IONOSPHERE AND AURORAL REGIONS, THE MAGNETOSPHERE, THE BOW SHOCK, MAGNETOSHEATH, AND BOUNDARIES OF THE MAGNETOSPHERE, IN THE SOLAR WIND, AND IN THE VICINITY OF THE MOON AND PLANETS. DC MEASUREMENTS IN THE AURORAL REGIONS ARE EXTREMELY VALUABLE, SINCE ANY COMPONENT OF ELECTRIC FIELD PARALLEL TO THE LOCAL MAGNETIC FIELD CAN BE RELATED DIRECTLY TO PARTICLE ACCELERATIONS, AND ANY PERPENDICULAR COMPONENTS

CAN BE RELATED TO LARGE-SCALE CURRENT SYSTEMS AND TO LARGE-SCALE CONVECTION IN THE OUTER MAGNETOSPHERE. DIRECT DC FIELD MEASUREMENTS IN THE OUTER MAGNETOSPHERE ARE NECESSARY TO ESTABLISH THE EXTENT OF CHARGED-PARTICLE CO-ROTATION WITH THE EARTH, CONVECTION, AND THE COUPLING OF CURRENT SYSTEMS BETWEEN THE MAGNETOSPHERE AND THE IONOSPHERE. DIFFERENCES IN MAGNETOSPHERIC DC ELECTRIC FIELDS MEASURED INSIDE AND OUTSIDE THE PLASMASPHERE WILL PROVIDE VALUABLE INFORMATION ON THE NATURE OF THE PLASMA MEDIUM. IN THE SOLAR WIND, ANY DEVIATIONS OF THE DC ELECTRIC FIELD FROM THE EXPECTED $V \times B$ FIELD MAY BE TAKEN AS EVIDENCE FOR DIFFUSION OR FRICTION OF SOLAR WIND PARTICLES, OR OF VISCOUS INTERACTIONS BETWEEN STREAMS OF PLASMA AT SECTOR OR FILAMENTARY BOUNDARIES. DC ELECTRIC FIELDS NEAR THE MOON AND PLANETS WILL ALSO BE IMPORTANT INDICATORS OF SOLAR-PLANETARY RELATIONSHIPS. AC ELECTRIC FIELDS ARE EXTREMELY IMPORTANT IN STUDIES OF WAVE PROPAGATION AND WAVE-PARTICLE INTERACTIONS. WHEN COMBINED WITH CORRESPONDING AC MAGNETIC FIELD INFORMATION, THESE MEASUREMENTS ARE POWERFUL INDICATORS OF ENERGY TRANSFER PROCESSES IN THE MAGNETOSPHERE AND BEYOND, AND THEY ALSO PROVIDE EXTREMELY VALUABLE CLUES ON PLASMA INSTABILITIES AND PARTICLE PITCH-ANGLE SCATTERING MECHANISMS. MOST CURRENT THEORIES OF THE EARTH'S BOW SHOCK MAINTAIN THAT THIS SHOCK STRUCTURE IS DETERMINED ENTIRELY BY HIGH-FREQUENCY ELECTROSTATIC WAVES, AT LEAST SOME OF WHICH ARE STANDING WAVES.

RTOP NO. 188-36-53 TITLE: MAGNETODYNAMICS/NON-THERMAL PLASMAS
 ORGANIZATION: NASA HEADQUARTERS
 MONITOR: KAVANAGH, L. D. TEL. 202-962-1987
 TECHNICAL SUMMARY

NON-THERMAL PLASMAS ARE CONSIDERED TO BE THOSE COLLECTIONS OF CHARGED PARTICLES WHICH ARE EITHER LOCATED OUTSIDE THE MAGNETOSPHERIC (OR PLANETARY) TRAPPING REGIONS, OR WHICH INSIDE THE MAGNETOSPHERE ARE ESPECIALLY RESPONSIVE TO PLASMA INSTABILITIES AND ELECTRIC FIELDS (I.E., DRIFT MOTIONS ARISING FROM ELECTRIC FIELDS DOMINATE OVER DRIFT MOTIONS ARISING FROM MAGNETIC-FIELD GRADIENTS). THUS, THIS CATEGORY OF PARTICLES INCLUDES: 1) THE SOLAR WIND; 2) CONCENTRATIONS OF PLASMA NEAR THE MOON AND PLANETS FORMING IN THE WAKE OF THE SOLAR WIND ABOUT THESE BODIES; 3) PARTICLES FORMING THE EARTH'S GEOMAGNETIC TAIL, PLASMA SHEET, AND "CUSP" REGION; 4) MAGNETOSHEATH PARTICLES AND PARTICLES ASSOCIATED WITH THE BOW SHOCK AND MAGNETOPAUSE; AND 5) PLASMASPHERE PARTICLES AND PARTICLES IN CONVECTIVE MOTION THROUGH THE OUTER ZONE OF THE MAGNETOSPHERE. OBJECTIVES ARE TO MEASURE THESE PARTICLES AND TO UNDERSTAND THEORETICALLY THEIR ORIGINS, THEIR TIME-VARYING BEHAVIOR, AND THEIR RELATION TO THE OVERALL MAGNETOSPHERE CONFIGURATION AND PLANETARY RADIATION ZONES. MEASUREMENTS OF THESE PARTICLES ARE ESPECIALLY VALUABLE WHEN COMBINED WITH CORRESPONDING ELECTRIC AND MAGNETIC-FIELD MEASUREMENTS, AND WITH SIMULTANEOUS MEASUREMENTS OF PARTICLES OF HIGHER ENERGY. A VARIETY OF INSTRUMENTS HAVE BEEN DESIGNED TO MEASURE THESE PARTICLES. SOME PROBLEMS ARISE WITH SPACECRAFT MEASUREMENTS AT VERY LOW PARTICLE ENERGIES (TENS OF EV OR LESS), WHEN THE ELECTRIC POTENTIAL OF THE SPACECRAFT BECOMES COMPARABLE TO THE ENERGY OF THE PARTICLES. PROBLEMS ALSO ARISE IN EXPERIMENTS FOR LONG-DURATION FLIGHTS, SINCE MANY OF THE MOST USEFUL DETECTORS HAVE LIMITED LIFETIMES.

RTOP NO. 188-36-54 TITLE: MAGNETODYNAMICS/AURORAL AND TRAPPED PARTICLES

ORGANIZATION: NASA HEADQUARTERS

MONITOR: KAVANAGH, L. D. TEL. 202-962-1987

TECHNICAL SUMMARY

THIS CATEGORY OF CHARGED PARTICLES INCLUDES PRECIPITATING ELECTRONS AND IONS FORMING THE AURORAS AND AIRGLOW; STABLY TRAPPED AND QUASI-TRAPPED PARTICLES IN THE EARTH'S MAGNETOSPHERE; CHARGED PARTICLES IN THE VICINITY OF THE EARTH ARISING THROUGH NEUTRON ALBEDO; THE MORE ENERGETIC PARTICLES IN THE SOLAR WIND; AND PARTICLES TRAPPED IN THE RADIATION ZONES OF THE PLANETS. OBJECTIVES ARE TO MEASURE THESE PARTICLES AND TO UNDERSTAND THEIR ORIGINS, THEIR TIME-VARYING BEHAVIOR, THEIR REACTION TO PERTURBATIONS, THEIR ADIABATIC AND NON-ADIABATIC MOTIONS, AND PROCESSES WHICH MAY AFFECT THEIR ENERGIES OR SPATIAL DISTRIBUTIONS. ALTHOUGH A GREAT DEAL OF DATA ON TRAPPED PARTICLES IN THE EARTH'S MAGNETOSPHERE HAS BEEN TAKEN THUS FAR, SUBSTANTIAL FURTHER INTERPRETATION OF THE DATA NEEDS TO BE MADE FOR A COMPLETE UNDERSTANDING OF THE DYNAMIC PROCESSES INVOLVED. IN ADDITION, AN EXPLORATORY SURVEY OF THE DISTRIBUTION OF THESE PARTICLES IS STILL NECESSARY IN CERTAIN REGIONS OF THE MAGNETOSPHERE, ESPECIALLY IN THE VICINITY OF THE MAGNETIC FIELD LINES ASSOCIATED WITH THE NEUTRAL POINTS. EXPLORATORY SURVEYS ARE ALSO NECESSARY OF THE RADIATION BELTS OF THE PLANETS, PARTICULARLY OF MERCURY, JUPITER, AND THE OUTER PLANETS SINCE THE RADIATION ZONES ON THESE ARE EXPECTED TO BE QUITE DIFFERENT FROM THE TRAPPING REGION AROUND THE EARTH. AURORAL PARTICLES ARE OF CONTINUING INTEREST INSOFAR AS THEY PROVIDE A TANGIBLE LINK BETWEEN GROUND OBSERVATIONS AND OBSERVATIONS OF THE OUTER MAGNETOSPHERE. OF SPECIAL INTEREST ARE CORRELATIONS OF AURORAL PARTICLE ACTIVITY WITH VLF WAVE ACTIVITY, SINCE THESE CAN BE DIRECTLY RELATED TO PLASMA INSTABILITIES AND TO OTHER PITCH-ANGLE SCATTERING MECHANISMS IN THE RADIATION ZONES. AURORAL SUBSTORMS ARE NOW THOUGHT TO BE ASSOCIATED WITH LARGE-SCALE ELECTRIC FIELDS IN THE MAGNETOSPHERE, BUT A FULLY SATISFYING EXPLANATION OF THE AURORAL PROCESS HAS THUS FAR BEEN ELUSIVE.

RTOP NO. 188-38-51 TITLE: DEVELOPMENT OF EXPERIMENTS AND HARDWARE FOR SOLAR PHYSICS RESEARCH

ORGANIZATION: NASA HEADQUARTERS

MONITOR: OERTEL, G. K. TEL. 202-962-0157

TECHNICAL SUMMARY

THE OBJECTIVE OF THE WORK UNDER THIS RTOP IS THE DEVELOPMENT OF EXPERIMENTS FOR SPACE FLIGHT OR LABORATORY APPLICATION, AND THE DEVELOPMENT OF CRITICAL TECHNOLOGY ITEMS WHICH ARE NEEDED FOR SOLAR OBSERVATIONS, OR WHICH CAN IMPROVE THEM SIGNIFICANTLY. INCLUDED ARE THE FOLLOWING ACTIVITIES: DEFINITION AND DEVELOPMENT OF EXPERIMENTS FOR EVENTUAL FLIGHT ON A ROCKET FOR SOLAR OBSERVATIONS ABOVE THE ATMOSPHERE. DEVELOPMENT OF A DEVICE FOR THE PRODUCTION OF OPTICAL COMPONENTS FOR USE IN SOLAR AND ASTRONOMICAL TELESCOPES, SPECTROGRAPHS, ETC., ON THE GROUND AND IN SPACE. DEVELOPMENT OF TECHNIQUES FOR IMPROVING THE PERFORMANCE OF OPTICAL INSTRUMENTATION IN SPACE AND ON THE GROUND. DEVELOPMENT OF TECHNIQUES FOR ACCURATE CALIBRATION OF INSTRUMENTATION IN SPACE AND ON THE GROUND IN PARTS OF

THE SPECTRUM WHERE THE AVAILABLE ACCURACY IS INSUFFICIENT FOR EFFECTIVE USE OF DATA FROM SPACE. DEVELOPMENT OF NOVEL TECHNIQUES FOR INCREASING THE INFORMATION VALUE OF PRESENT EXPERIMENTS.

RTOP NO. 188-38-52 TITLE: GROUND-BASED OBSERVATIONS OF THE SUN

ORGANIZATION: NASA HEADQUARTERS

MONITOR: OERTEL, G. K. TEL. 202-962-0157

TECHNICAL SUMMARY

GROUND-BASED OBSERVATIONS OF THE SUN IN WAVELENGTHS FOR WHICH THE ATMOSPHERE IS TRANSPARENT ARE CARRIED OUT AT A NUMBER OF SUITABLE OBSERVATORIES AND GROUND STATIONS THROUGHOUT THE UNITED STATES. THE PURPOSE OF THESE GROUND-BASED OBSERVATIONS IS TO OBTAIN INFORMATION ON THE SOLAR ATMOSPHERE FROM THE PHOTOSPHERE AND SUNSPOTS, TO THE CHROMOSPHERE AND THE CORONA, AND ON THE FINE AND GROSS STRUCTURE OF THE SOLAR ATMOSPHERE, AND ACTIVITY IN IT. THIS INFORMATION IS THEN USED IN CORRELATION WITH OBSERVATIONS FROM SOUNDING ROCKETS, OSOS, ATM AND OTHER SPACECRAFT TO DETERMINE THE PHYSICAL CONDITIONS IN THE OBJECTS STUDIES, AND TO UNDERSTAND THE PHYSICAL MECHANISMS AT WORK IN THEM. SPECIFICALLY THE FOLLOWING TYPES OF ACTIVITY ARE COVERED UNDER THIS RTOP (GROUND-BASED HERE REFERS TO AIRCRAFT AND BALLOONS AS WELL AS TO FIXED INSTALLATIONS ON THE GROUND): THE DEFINITION AND DESIGN OF EXPERIMENTS FOR GROUND-BASED OBSERVATORIES. THE CONSTRUCTION OR PURCHASE AND OPERATION OF SUCH EXPERIMENTS. THE OBSERVING OF THE SUN, AND FEATURES IN IT, FROM THE GROUND. THE ANALYSIS OF GROUND-BASED DATA IN CORRELATION WITH DATA FROM SPACE OR FROM OTHER GROUND-BASED OBSERVATORIES. SCIENTIFIC INTERPRETATION IN TERMS OF PHYSICAL CONDITIONS AND MECHANISMS.

RTOP NO. 188-38-53 TITLE: LABORATORY AND THEORETICAL SOLAR PHYSICS

ORGANIZATION: NASA HEADQUARTERS

MONITOR: OERTEL, G. K. TEL. 202-962-0157

TECHNICAL SUMMARY

LABORATORY AND THEORETICAL STUDIES ARE CARRIED OUT ON CURRENT PROBLEMS IN SOLAR ASTRONOMY AND SOLAR PHYSICS, AND ON IMPORTANT AREAS OF ATOMIC AND MOLECULAR PHYSICS WHICH ARE CONTRIBUTING BASIC INFORMATION AS REQUIRED FOR THE ANALYSIS OR UNDERSTANDING OF SOLAR DATA FROM THE GROUND AND FROM SPACE. THEORETICAL STUDIES OF THE SUN INCLUDE THE FOLLOWING TYPES OF ACTIVITY: THE ANALYSIS OF GROUND-BASED AND SPACE DATA IN TERMS OF MODELS OF THE SOLAR ATMOSPHERE ACTIVITY, OR STRUCTURES. SCIENTIFIC INTERPRETATION IN TERMS OF PHYSICAL CONDITIONS AND MECHANISMS. PREDICTION OF FUTURE EVENTS ON THE SUN, SUCH AS PREDICTIONS OF CORONAL STRUCTURES FROM FEATURES OBSERVABLE ON THE DISK; OF THE DEVELOPMENT OF FUTURE ACTIVE REGIONS FROM MAGNETIC AND H-ALPHA FEATURES; THE OCCURRENCE OF FLARES FROM MAGNETIC FIELD COMPLEXITY AND CONFIGURATION. THEORETICAL AND LABORATORY STUDIES IN ATOMIC AND MOLECULAR PHYSICS INCLUDE THESE ACTIVITIES: THE MEASUREMENT OR COMPUTATION OF ATOMIC OR MOLECULAR QUANTITIES SUCH AS WAVELENGTHS, ENERGY LEVELS, F-VALUES, LINE BROADENING PARAMETERS, IONIZATION AND EXCITATION FUNCTIONS, ETC. THE PRODUCTION OF PLASMAS WHICH SIMULATE BY SCALING PART OR ALL OF THE

CONDITIONS IN PARTICULAR SOLAR PHENOMENA OR STRUCTURES IN THE LABORATORY. THE STUDY OF BASIC PHYSICAL PROCESSES SUCH AS OSCILLATIONS UNDER CONDITIONS AS THEY ARE FOUND IN THE SOLAR ATMOSPHERE, AND WHICH CAN BE EXPECTED TO FORM THE BASIS FOR AN UNDERSTANDING OF SOLAR PHENOMENA.

RTOP NO. 188-39-51 TITLE: INTERPLANETARY PHYSICS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: SCHMERLING, E. R. TEL. 202-962-1973
TECHNICAL SUMMARY

THE OBJECTIVE IS TO STUDY THE PHENOMENA WHICH CAN BE OBSERVED IN INTERPLANETARY SPACE, OUTSIDE THE MAGNETOSPHERIC ENVELOPES OF THE EARTH, THE MOON, THE PLANETS, AND THE IMMEDIATE ENVIRONMENT (CORONA) OF THE SUN. THESE CONSIST OF PLASMA STREAMS, ELECTRIC AND MAGNETIC FIELDS, CHARGED PARTICLES AND COSMIC RAYS. METHODS OF STUDY INCLUDE THE "REMOTE SENSING" TECHNIQUES BASED ON THE USE OF RADIO WAVES, AND THE IN-SITU MEASUREMENTS MADE BY THE USE OF INSTRUMENTS CARRIED ON SPACE PROBES.

RTOP NO. 188-39-52 TITLE: UPPER PLANETARY IONOSPHERES
ORGANIZATION: NASA HEADQUARTERS
MONITOR: SCHMERLING, E. R. TEL. 202-962-1973
TECHNICAL SUMMARY

1. TO SURVEY THE CONSTITUENTS, THEIR CONCENTRATIONS AND TEMPERATURES, IN THE UPPER IONOSPHERES OF THE EARTH AND PLANETS AND DETERMINE THEIR VARIATIONS WITH POSITION, TIME AND SOLAR ACTIVITY.
2. TO IMPROVE OUR UNDERSTANDING OF THE PROCESSES BY WHICH IONIZATION IS PRODUCED, DISPLACED AND REMOVED BY RECOMBINATION PROCESSES.
3. TO IMPROVE METHODS FOR THE MEASUREMENT OF IONOSPHERIC PARAMETERS, ESPECIALLY AROUND THE PLANETS.

RTOP NO. 188-39-53 TITLE: LOWER PLANETARY IONOSPHERES
ORGANIZATION: NASA HEADQUARTERS
MONITOR: SCHMERLING, E. R. TEL. 202-962-1973
TECHNICAL SUMMARY

1. DEVELOPMENT OF MEASURING TECHNIQUES APPLICABLE FOR THE FIRST 100 KM OF THE TERRESTRIAL IONOSPHERE, AND CORRESPONDING PORTIONS OF THE LOWER IONOSPHERES OF THE PLANETS. THIS REQUIRES THE DEVELOPMENT OF POSITIVE AND NEGATIVE ION SPECTROMETERS CAPABLE OF WORKING AT PRESSURES GREATER THAN .00010 MM HG, AND OTHER TECHNIQUES FOR DETERMINING ELECTRON CONCENTRATIONS AND TEMPERATURES.
2. FORMULATION OF MODELS OF THE LOWER IONOSPHERES OF EARTH AND THE PLANETS.
3. DETERMINATION OF THE REACTION RATES FOR THE PERTINENT ION-ELECTRON AND ION-MOLECULE REACTIONS.
4. DETERMINATION OF CIRCULATION AND WAVE-DISTURBANCE EFFECTS IN THE MEDIUM.

RTOP NO. 188-39-54 TITLE: PARTICLE-WAVE INTERACTIONS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: SCHMERLING, E. R. TEL. 202-962-1973
TECHNICAL SUMMARY

NEUTRAL AND CHARGED PARTICLES IN THE ENVIRONMENTS OF THE PLANETS, IN INTERPLANETARY SPACE, IN THE SOLAR CORONA AND IN THE LABORATORY, AFFECT THE PROPAGATION OF RADIO WAVES. THIS INTERACTION CAN BE USED TO MEASURE THE MEDIUM AND, CONVERSELY, REQUIRES CORRECTIONS TO BE MADE IN PRECISION TRACKING SYSTEMS. STRONGER INTERACTIONS OCCUR UNDER SOME CIRCUMSTANCES WHICH LEAD TO THE GENERATION OF RADIO SIGNALS FROM PLASMA MOTIONS, AND THE AMPLIFICATION OF RADIO SIGNALS. CONVERSELY, CHARGED PARTICLES CAN BE ACCELERATED AND DECELERATED BY ELECTROMAGNETIC WAVES.

RTOP NO. 188-41-51 TITLE: GROUND-BASED ASTRONOMY - OPTICAL
ORGANIZATION: NASA HEADQUARTERS
MONITOR: ROMAN, N. G. TEL. 202-962-2989
TECHNICAL SUMMARY

THE GENERAL OBJECTIVES ARE THE CONTINUING DEVELOPMENTS AND MAINTENANCE OF INSTRUMENTATIONS AND FACILITIES FOR GROUND-BASED TELESCOPES. THESE EQUIPMENTS ARE USED FOR GENERAL ASTRONOMICAL RESEARCH. GROUND-BASED ASTRONOMY INCLUDES THE DEVELOPMENT OF IMPROVED EQUIPMENT TO IMPLEMENT ASTRONOMICAL OBSERVATIONS AND THEIR INTERPRETATION.

RTOP NO. 188-41-55 TITLE: INFRARED ASTRONOMY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: BOGGESS, N. W. TEL. 202-963-5997
TECHNICAL SUMMARY

THE OBJECTIVE IS TO STUDY OBJECTS IN THE INFRARED (IR) BY MEANS OF GROUND-BASED TELESCOPES, AIRPLANES, ROCKETS, AND BALLOONS AND ASSOCIATED EQUIPMENT. IN ADDITION, TO DEVELOP DETECTORS AND CRYOGENICS SO THAT SATELLITES COULD BE USED FOR INFRARED RESEARCH.

RTOP NO. 188-41-58 TITLE: SUPPORTING TASKS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: OTT, E. J. TEL. 202-963-5996
TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE A BASE FROM WHICH SPECIAL PROJECTS OF PARTICULARLY HIGH INTEREST TO THE NASA ASTRONOMY PROGRAM MAY BE CARRIED TO TIMELY CONCLUSION. THE TASKS ARE GREATLY VARIED.

RTOP NO. 188-45-51 TITLE: COMETS AND ASTEROIDS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: DUBIN, M. TEL. 202-962-2847
TECHNICAL SUMMARY

THE COMETS AND ASTEROIDS RESEARCH PLAN INCLUDES OBSERVATIONAL INVESTIGATIONS OF COMETS, ASTEROIDS, ZODIACAL LIGHT, AND THE GEGENSCHNEIN, AS WELL AS INVESTIGATION OF THE CHEMISTRY AND PHYSICS OF ENSEMBLES OF GASES, PLASMAS, AND MICRO-PARTICLES USING EXPERIMENTS IN THE LABORATORY AND IN SPACE. THE ASTRONOMICAL STUDIES INCLUDE OBSERVATIONS OF THE MORPHOLOGY, POLARIZATION, SPECTRAL DISTRIBUTION OF BRIGHT COMETS, ASTEROIDS, THE ZODIACAL LIGHT AND GEGENSCHNEIN. THE OBSERVATIONS ARE CARRIED OUT FROM GROUND BASED OBSERVATORIES AND, ALSO, FROM AIRCRAFT OBSERVATORIES AND BALLOONS. ASTROMETRIC MEASUREMENTS AND THE SEARCH FOR NEW COMETS AND ASTEROIDS ARE ALSO CARRIED OUT. THE PHYSICS OF COMETS INCLUDES RESEARCH ABOUT THE DYNAMIC PROCESSES IN COMETS AND THE INTERACTIONS OF THE COMAS AND TAILS WITH SOLAR RADIATIONS AND SOLAR STREAMS. FROM THE OBSERVATIONAL PROGRAM THE COMPOSITION OF THE COMA AND TAILS OF COMETS MAY BE DERIVED AND THE EVOLUTIONARY DEVELOPMENT OF COMETS MAY BE OBSERVED IN RELATION TO THE PERTURBING FORCES OF SOLAR RADIATIONS. MEASUREMENTS OF THE TEMPORAL DISTRIBUTIONS IN THE COMA AND MEASUREMENTS OF TEMPERATURES OF GAS AND GRAINS MAY BE MADE. THE EVOLUTIONARY PROCESSES AS OBSERVED FROM THE COMET'S DISSOLUTION CAN BE COMPARED TO EXPERIMENTAL AND ANALYTICAL REACTION RATES. THE EFFECTIVENESS OF THE VARIOUS REACTIONS ARE NEEDED TO UNDERSTAND THE COMPOSITION, STRUCTURE, AND PHYSICAL-CHEMICAL PROCESSES OCCURRING IN THE EVOLUTION OF EXTRATERRESTRIAL MATTER. A KNOWLEDGE OF THE DYNAMIC CONDITIONS IS IMPORTANT IN UNDERSTANDING THE ORIGIN AND DEVELOPMENT OF ASTEROIDS PLANETOIDS, AND STELLAR SYSTEMS. THE OBSERVATIONS OF THE ASTEROIDS YIELD INFORMATION ON THE SHAPE, MODES OF ROTATION, CROSS-SECTION AND SURFACE CHARACTERISTICS. IT IS EXPECTED THAT INTERPLANETARY PROBES WILL BE SENT TO VARIOUS COMETS AND ASTEROIDS.

RTOP NO. 188-45-52 TITLE: METEOR ASTRONOMY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: DUBIN, M. TEL. 202-962-2847
TECHNICAL SUMMARY

METEOR ASTRONOMY IS THE STUDY OF THE SOLID BODIES, METEOROIDS, IN THE SOLAR SYSTEM FROM THE OBSERVATIONAL REACTIONS IN THE EARTH'S ATMOSPHERE. FROM OBSERVATIONS OF METEORS' TRACK INTENSITIES, VELOCITIES, AND SPECTROSCOPIC CHARACTERISTICS, THE ORBITS, POPULATION DISTRIBUTION, MASS DISTRIBUTIONS AND COMPOSITIONS OF METEOROIDS ARE DETERMINABLE. THE OBSERVATIONAL METHODS INCLUDE PHOTOGRAPHIC AND IMAGE INTENSIFIER OBSERVATIONS OF METEORS AND OBSERVATIONS WITH RADAR AND LASERS. THE RESEARCH ON METEORS IS CONCENTRATED PRESENTLY ON THE EXTREMES OF THE METEOR MAGNITUDE SCALE, THE VERY BRIGHT METEORS WITH MASSES OF KILOGRAMS TO SEVERAL TONS AND THE MINUTE PARTICLES WITH RADAR AND LASER BEAMS. THE INVESTIGATIONS ENCOMPASS THE PH FORMATION, THE RADIATIVE AND ELECTROMAGNETICAL MECHANISMS AND THEORIES OF METEORNETIC PROCESSES IN THE INTERACTION WITH THE ATMOSPHERE AND THE STRUCTURAL COHERENCE OF THE METEOROIDS. THE GREAT MAJORITY OF METEOROIDS ARE VERY LIKELY OF COMETARY ORIGIN AND REPRESENT THE MAJOR

SOURCE FOR THE ACQUISITION OF PRIMORDIAL INTERPLANETARY GRAINS INVOLVED IN THE ORIGINAL SOLAR NEBULA AS WELL AS INTERSTELLAR ORIGIN. STREAM METEORS ARE DERIVED FROM COMETS IN MANY CASES. THE OPTICAL STUDIES OF THE BRIGHT METEORS REPRESENT A SOURCE FOR ACQUIRING COSMIC PARTICLES FROM THE DETERMINATION OF THE IMPACT RE METEORITE FINDS. A METHOD FOR THE CAPTION AND WITH THE SIGNIFICANT EXPECTATION OF FUTURE OF THE GRAINS WITH AN AIRCRAFT COLLECTION SYSTEM DIRECTLY AFTER FIREBALL PASSAGE HAS BEEN DEVELOPED. THE METEOR ASTRONOMY PROGRAM CONTRIBUTES ALSO TO ENTRY BALLISTICS, AND TO ATMOSPHERIC PHYSICS IN ITS EFFECTS ON THE IONOSPHERE. THE CLASSIFICATION OF THE COMPOSITIONS OF THE METEORS WILL CONTRIBUTE TO THE PLANNING OF MISSIONS INVOLVING PROBES TO COMETS AND ASTEROIDS.

RTOP NO. 188-45-53 TITLE: COSMIC DUST RESEARCH
ORGANIZATION: NASA HEADQUARTERS
MONITOR: DUBIN, M. TEL. 202-962-2847
TECHNICAL SUMMARY

COSMIC DUST RESEARCH IS THE EXPERIMENTAL WORK WHICH UNDERLIES THE INVESTIGATION OF THE COMPOSITION, STRUCTURE, AND POPULATION DENSITY OF SMALL INTERPLANETARY PARTICLES. THE DESIGN AND CALIBRATION OF INSTRUMENTS FOR FLIGHT INVOLVING IN SITU OBSERVATIONS, THE DESIGN OF COLLECTION SYSTEMS, AND THE ANALYSIS OF COLLECTED PARTICLES ARE INCLUDED IN THIS RESEARCH AREA. COLLECTION SYSTEMS USING AIRCRAFT AND BALLOONS ARE SUPPORTED WITHIN THIS PROGRAM ELEMENT. THE HIGHLY SOPHISTICATED AND ANALYTICAL METHODS OF ANALYZING MICRO-PARTICLES WITH DIMENSIONS AS LOW AS A 0.1 MICRON POINT TO THE OPPORTUNITY OF STUDYING THE PRIMORDIAL NATURE OF EXTERRESTRIAL GRAINS. PARTICLE ANALYSIS WITH ELECTRON AND STEREO-SCAN MICROSCOPY, AND X-RAY DIFFRACTION TECHNIQUES HAVE PROVED EFFECTIVE FOR COSMIC DUST ANALYSIS IN THE SUBMICRON SIZE-RANGE. COLLECTION TECHNIQUES HAVE BEEN DEVELOPED AND A COLLECTION PROGRAM IS BEING UNDERTAKEN USING METEOR ASTRONOMY DATA. COLLECTIONS SYSTEMS FROM BALLOONS ARE EFFECTIVE AT MESOSPHERIC ALTITUDES AND AIRCRAFT COLLECTION METHODS FOLLOWING PRAIRIE NETWORK FIREBALL SIGHTINGS HAVE BEEN SUCCESSFUL. THE EXPERIMENTAL RESULTS MAY BE CORRELATED WITH MEASUREMENTS ON SPACE VEHICLES FOR THE DETERMINATION OF THE STRUCTURE AND COMPOSITION OF PARTICLES. THE OBSERVATIONAL AND EXPERIMENTAL METHODS CONTRIBUTE, ALSO, TO THE DESIGN OF EXPERIMENTS FOR PROBES TO THE COMETS AND ASTEROIDS. THE COMPOSITIONAL ANALYSIS OF RECOVERED SAMPLES SHOULD RELATE ALSO TO THE COMPOSITION DERIVED FROM THE SPECTROSCOPIC OBSERVATIONS OF COMETS AND METEORS. THE CLASSIFICATION OF THE COMPOSITION OF THE ORIGINAL SOLAR NEBULA, AND POSSIBILITY OF MEASURING THE COMPOSITION OF SOLID MATTER OF INTERSTELLAR ORIGIN ARE INDICATIVE OF THE FUNDAMENTAL BASIS OF THIS RESEARCH; THE EXISTENCE OF COMPLEX ORGANIC MOLECULES IN THE POPULATION OF COSMIC DUST IS OF BIOGENETIC INTEREST.

RTOP NO. 188-46-51 TITLE: LOW ENERGY COSMIC RAYS
ORGANIZATION: HEADQUARTERS
MONITOR: OPP, A. G. TEL. 202-962-1987
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO STUDY THE COMPOSITION AND PROPAGATION OF SOLAR AND GALACTIC COSMIC RAYS WITH ENERGIES LESS THAN 10 BEV. THE PRIMARY GALACTIC RADIATION REPRESENTS THE DIRECT PENETRATION OF MATERIAL FROM THE GALAXY INTO THE SOLAR SYSTEM. THE STUDY OF THE NUCLEAR COMPOSITION AND ENERGY OF THIS MATERIAL PROVIDES DIRECT EVIDENCE ON THE STELLAR PROCESSES WHICH CREATED THE COSMIC RADIATION AND INFORMATION ON THE INTERSTELLAR MATERIAL, THROUGH WHICH THE COSMIC RADIATION HAS PASSED. THE TOTAL ENERGY CONTENT OF THE GALACTIC COSMIC RAY GAS IS HIGH, AND IT IS BELIEVED TO BE A MAJOR FACTOR IN THE STABILITY OF A GALAXY. THE OBSERVATION OF SOLAR COSMIC RAYS PROVIDES INFORMATION ON THE ABUNDANCES OF DIFFERENT ELEMENTS IN THE SUN AND INFORMATION ON THE SOLAR PROCESSES WHICH ACCELERATE THE COSMIC RAY PARTICLES TO THEIR OBSERVED ENERGIES. SIMILARLY, THE MEASUREMENT OF SOLAR NEUTRONS WILL GIVE INFORMATION ON THERMONUCLEAR REACTIONS IN THE SUN AND MECHANISMS RESPONSIBLE FOR ACCELERATING CHARGED PARTICLES IN SOLAR FLARES. IT IS ALSO NECESSARY TO BE ABLE TO ASSESS THE HAZARD OF SOLAR FLARE PARTICLE BURSTS ON ASTRONAUT OPERATIONS AND ON THE OPERATION OF RADIATION-SENSITIVE SPACECRAFT COMPONENTS. THE COSMIC RAY PARTICLES CONSIDERED HERE CAN BE OBSERVED BY SOLID STATE DETECTORS, SCINTILLATORS, NUCLEAR EMULSIONS AND SIMILAR NUCLEAR DETECTORS. FUNDS PROVIDED HERE ARE UTILIZED TO CONDUCT LABORATORY AND BALLOON TESTS OF NEW INSTRUMENT CONCEPTS AS WELL AS FOR THEORETICAL STUDIES OF COSMIC RAY PHENOMENA.

RTOP NO. 188-46-52 TITLE: HIGH ENERGY COSMIC RAYS
ORGANIZATION: HEADQUARTERS
MONITOR: OPP, A. G. TEL. 202-962-1987
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO STUDY THE COMPOSITION AND PROPAGATION OF PRIMARY COSMIC RADIATION GREATER THAN 10BEV IN ENERGY. COSMIC RAYS IN THIS ENERGY RANGE PROVIDE INFORMATION ON VERY HIGH ENERGY PROCESSES OCCURRING IN STELLAR REACTIONS. THE ENERGY OF SOME COSMIC RAY PARTICLES PRESENTLY EXCEEDS THE ENERGIES AVAILABLE FROM GROUND-BASED ACCELERATORS. VERY HIGH ENERGY NUCLEAR PARTICLE INTERACTIONS, WHICH CANNOT BE STUDIED IN TERRESTRIAL LABORATORIES, CAN BE STUDIED IN SPACE. THE HIGH ENERGY OF THESE PARTICLES REQUIRES LARGE SOPHISTICATED INSTRUMENTATION TO DEFINE THE CHARACTERISTICS OF THE COSMIC RAY PARTICLE AND TO ANALYZE THE RESULTING INTERACTION. THESE EFFECTS ARE STUDIED WITH INSTRUMENTS SUCH AS IONIZATION SPECTROMETERS, TOTAL ABSORPTION CASCADE DETECTORS AND TRANSITION RADIATION DETECTORS. THE SIZE AND COMPLEXITY OF THESE INSTRUMENTS REQUIRES EXTENSIVE DEVELOPMENT AND BALLOON TESTING PRIOR TO FLIGHT ON A SPACECRAFT.

RTOP NO. 188-46-53 TITLE: GREATER THAN 10 KEV X-RAY ASTRONOMY
ORGANIZATION: HEADQUARTERS
MONITOR: OPP, A. G. TEL. 202-962-1987
TECHNICAL SUMMARY

SEVERAL X-RAY SOURCES HAVE BEEN IDENTIFIED, WHICH HAVE SPECTRA EXTENDING INTO THE TENS OF KEV ENERGY RANGE. IN ADDITION, A DIFFUSE X-RAY BACKGROUND HAS BEEN IDENTIFIED. THE BACKGROUND IS PREDICTED TO ORIGINATE FROM A COMBINATION OF CONTRIBUTION FROM DISCREET SOURCES AND A CONTRIBUTION FROM THE INTERACTION OF HIGH ENERGY COSMIC RAY ELECTRONS WITH THE 2.7 DEGREES K BACKGROUND RADIATION. THE SPECTRA OF THE DISCREET SOURCES AND THE SPECTRA AND CELESTIAL DISTRIBUTION OF THE X-RAY BACKGROUND WILL PROVIDE INFORMATION ON STELLAR PROCESSES AS WELL AS ON PHYSICAL PROCESSES IN GALACTIC AND EXTRAGALACTIC SPACE. SOLID STATE DETECTORS AND LARGE INORGANIC SCINTILLATORS HAVE BEEN USED FOR MEASUREMENTS IN THIS ENERGY REGION. SOLID STATE DETECTORS GENERALLY MUST BE COOLED AND LARGE SCINTILLATORS ARE RELATIVELY FRAGILE IN THE SPACE AND LAUNCH ENVIRONMENTS. TECHNICAL DEVELOPMENT IS REQUIRED TO PERFECT THESE SENSORS FOR SPACE USE.

RTOP NO. 188-46-54 TITLE: GAMMA-RAY ASTRONOMY
ORGANIZATION: HEADQUARTERS
MONITOR: OPP, A. G. TEL. 202-962-1987
TECHNICAL SUMMARY

GAMMA-RAY PHOTONS RESULT FROM A NUMBER OF PHYSICAL PROCESSES (SEE ITEM 14). THESE PROCESSES CAN FURNISH INFORMATION ON THE SYNTHESIS AND DISTRIBUTION OF ELEMENTS IN THE UNIVERSE, ON THE MAGNETOPLASMA ENVIRONMENT OF A STAR, ON THE CONDENSATION AND INTERACTION OF INTERSTELLAR MATERIAL WITH RADIATION, AS WELL AS OTHER ASTROPHYSICALLY IMPORTANT PARAMETERS. GAMMA RAYS, WHICH ARE UNDEFLECTED BY MAGNETIC FIELDS, TRAVEL DIRECTLY FROM THEIR SOURCES, AND ANISOTROPIES IN THE DIRECTION OF ARRIVAL OF THE PHOTONS GIVES INFORMATION ON THE LOCATION OF THE GAMMA-RAY SOURCES. THE HIGH GAMMA-RAY BACKGROUND OF THE EARTH AND THE HIGH ENERGY OF SEVERAL OF THE GAMMA RAYS OF INTEREST REQUIRES SOPHISTICATED INSTRUMENTATION CAPABLE OF ABSORBING HIGH ENERGY PHOTONS WITH SATISFACTORY DIRECTIONALITY AND SHIELDING TO PROTECT AGAINST BACKGROUND AND TO DETERMINE THE DIRECTION OF ARRIVAL OF THE PHOTON. INSTRUMENTATION USED FOR THESE INVESTIGATIONS ARE SPARK CHAMBERS, LARGE INORGANIC SCINTILLATORS AND CERENKOV COUNTERS. THE PRIMARY OBJECTIVE OF THIS TASK IS TO DEVELOP THESE DETECTORS, SUCH THAT UNAMBIGUOUS MEASUREMENTS OF HIGH ENERGY PHOTONS CAN BE MADE IN SPACE.

RTOP NO. 188-48-51 TITLE: INSTITUTIONAL SUPPORT
ORGANIZATION: NASA HEADQUARTERS
MONITOR: TATE, F. G. TEL. 202-963-4736
TECHNICAL SUMMARY

THIS COVERS THE INSTITUTIONAL RTOP, PROVIDES INSTITUTIONAL SUPPORT FOR THE PHYSICS AND ASTRONOMY PROGRAM. AMONG THE ITEMS: ADVISORY BOARDS - TO SUPPORT THE ACTIVITIES OF ADVISORY BOARDS AS REQUIRED INCLUDING NASA ESTABLISHED BOARDS AND THE SPACE SCIENCE

BOARD IN DEVELOPING OVER ALL OBJECTIVES FOR SPACE RESEARCH, IN FORMULATING GUIDING PRINCIPLES FOR NASA OPERATING PROGRAMS, IN SERVING AS A STIMULUS TO THE SCIENTIFIC COMMUNITY, AND MAINTAINING LIAISON WITH INTERNATIONAL SPACE EFFORT. RESIDENT RESEARCH ASSOCIATESHIP PROGRAM FOR NASA - TO PROVIDE CONTINUATION OF THE POST-DOCTORAL RESIDENT RESEARCH ASSOCIATESHIP PROGRAM OF THE NATIONAL ACADEMY OF SCIENCES/NATIONAL RESEARCH COUNCIL FOR NASA; BASICALLY TO PROVIDE INVESTIGATORS AN OPPORTUNITY FOR ADVANCED TRAINING IN SPACE SCIENCES IN SEVERAL NASA CENTERS. DOCUMENTATION AND PLANNING - TO PROVIDE FOR SCIENTIFIC AND TECHNICAL SUPPORT SERVICES. THE CONTRACTOR CONDUCTS SCIENTIFIC REVIEWS AND PREPARES DOCUMENTATION IN SUPPORT OF PHYSICS AND ASTRONOMY AND RELATED NASA RESEARCH AND DEVELOPMENT ACTIVITIES. GODDARD INSTITUTE OF SPACE STUDIES (GISS) - FOR COMPLETE MATHEMATICAL ANALYSIS, PROGRAMMING AND OPERATIONAL AND RELATED SERVICES FOR THE GISS COMPUTING AND RELATED RESEARCH FACILITIES INCLUDING PURCHASE OF EQUIPMENT AND EXECUTION OF A DYNAMIC COOPERATIVE UNIVERSITY PROGRAM THRU RESEARCH GRANTS.

RTOP NO. 188-48-52 TITLE: BASIC THEORETICAL RESEARCH
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: TEMKIN, A. TEL. 301-982-5213
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP TECHNIQUES FOR THE SOLUTION OF BASIC (PROTOTYPE) ATOMIC COLLISION PROBLEMS INVOLVED IN PROCESSES OCCURRING IN PLANETARY AND STELLAR ATMOSPHERES, AND IN OTHER PLASMAS; ALSO FOR COLLISION PROCESSES THAT MAY BE USED AS DIAGNOSTIC TOOLS IN ATMOSPHERES. SPECIFIC WORK IMPLEMENTING THE ABOVE OBJECTIVE FALL IN THE FOLLOWING GENERAL CATEGORIES: 1. STUDY OF ELECTRON IMPACT IONIZATION. 2. CALCULATIONS OF AUTOIONIZATION STATES OF ATOMIC SYSTEMS. 3. CALCULATION OF ELECTRON MOLECULE SCATTERING TECHNIQUES. 4. STUDY OF POSITRON-ATOM SCATTERING AND REACTIONS. 5. STUDY OF PROTON-HYDROGEN COLLISIONS. 6. INVESTIGATION OF MATTER-ANTIMATTER ANNIHILATION AND ITS COSMIC SIGNIFICANCE. 7. STUDY OF PHOTOIONIZATION PROCESSES.

RTOP NO. 188-48-54 TITLE: BALLOON SUPPORT
ORGANIZATION: NASA HEADQUARTERS
MONITOR: HOLTZ, J. R. TEL. 202-962-3825
TECHNICAL SUMMARY

TO PROVIDE THE BALLOONS, HELIUM AND LAUNCH SUPPORT SERVICES REQUIRED TO CONDUCT BALLOON FLIGHTS OF SCIENTIFIC EXPERIMENTS OF CERTAIN NASA-SPONSORED INVESTIGATORS AND CONDUCT R&D PROGRAMS AIMED AT IMPROVING THE CAPABILITIES AND RELIABILITY OF SCIENTIFIC BALLOONING. NATIONAL CENTER FOR ATMOSPHERIC RESEARCH (NCAR) PURCHASES BALLOONS AND HELIUM FOR FLIGHTS FROM THE NCAR LAUNCH FACILITIES AT PALESTINE, TEXAS, AND PAGE, ARIZONA. NCAR ALSO CONDUCTS R&D PROGRAMS BOTH INHOUSE AND UNDER SUBCONTRACT, TO IMPROVE THE STATE OF THE ART IN BALLOON MATERIAL DESIGN, LAUNCH SYSTEMS AND INSTRUMENTATION. OFFICE OF NAVAL RESEARCH (ONR) CONDUCTS "OPERATION SKYHOOK" WHICH INVOLVES THE LAUNCH OF SCIENTIFIC BALLOONS FROM

LOCATIONS WHERE PERMANENT LAUNCH FACILITIES DO NOT EXIST, PRINCIPALLY AT FORT CHURCHILL, CANADA. A MAJOR PORTION OF THIS OPERATION INVOLVES FLIGHTS OF EXPERIMENTS OF NASA-SPONSORED SCIENTISTS. THE PURCHASE OF BALLOONS, AND LAUNCH AND FIELD SERVICES ARE SUBCONTRACTED TO APPROPRIATE BALLOON MANUFACTURERS BY ONR WHICH MONITORS ALL ACTIVITIES. THIS IS A CONTINUING PROGRAM WHICH INVOLVES APPROXIMATELY 60 FLIGHTS PER YEAR.

RTOP NO. 188-78-51 TITLE: ADVANCED TECHNOLOGICAL DEVELOPMENT GENERAL
ORGANIZATION: NASA HEADQUARTERS
MONITOR: AUCREMANNE, M. J. TEL. 202-962-1983
TECHNICAL SUMMARY

IN ORDER TO CARRY OUT MORE SOPHISTICATED SPACEBORNE ASTRONOMICAL AND PHYSICAL OBSERVATIONS IT IS NECESSARY TO IDENTIFY TECHNOLOGICAL REQUIREMENTS AND ESTABLISH SUITABLE RESEARCH AND DEVELOPMENT PROGRAMS TO OVERCOME THESE DEFICIENCIES. ALBEIT NO ONE SPECIFIC TECHNOLOGY IS CONSIDERED, THEY RANGE FROM SPACE PHYSICS TECHNOLOGY TO THERMAL STUDIES ON THE PRIMARY MIRROR OF SOLAR TELESCOPES, TO X-RAY IMAGING AND DETECTION SYSTEMS, TO DIGITIZED ELECTRONIC IMAGING SYSTEMS OF STELLAR PHENOMENA.

RTOP NO. 188-78-52 TITLE: HIGH ENERGY ASTRONOMY
OBSERVATORY/SPACECRAFT
ORGANIZATION: NASA HEADQUARTERS
MONITOR: AUCREMANNE, M. J. TEL. 202-962-1983
TECHNICAL SUMMARY

IN ORDER TO IMPLEMENT THE HIGH ENERGY ASTRONOMY OBSERVATORY (HEAO) PROGRAM IT WILL BE NECESSARY TO DEVELOP SUITABLE SPACECRAFT CAPABLE OF ACCOMPLISHING THE UNIQUE REQUIREMENTS OF X-, GAMMA-, AND COSMIC RAY OBSERVATIONS. IN ORDER TO ACCOMPLISH THIS IT WILL BE NECESSARY TO DEFINE MISSION AND SPACECRAFT PARAMETERS TO MEET THE SCIENTIFIC OBJECTIVES AND THEN PERFORM CONCEPTUAL, FEASIBILITY, AND DEFINITION STUDIES TO DEVELOP THE SPECIFICATION REQUIREMENTS.

RTOP NO. 188-78-53 TITLE: HIGH ENERGY ASTRONOMY
OBSERVATORY/INSTRUMENTATION
ORGANIZATION: NASA HEADQUARTERS
MONITOR: AUCREMANNE, M. J. TEL. 202-962-1983
TECHNICAL SUMMARY

IN ORDER TO IMPLEMENT THE HIGH ENERGY ASTRONOMY OBSERVATORY (HEAO) PROGRAM IT WILL BE NECESSARY TO DEVELOP SUITABLE SPACEBORNE INSTRUMENTATION IN THE AREAS OF X- AND GAMMA RAY ASTRONOMY AND COSMIC RAY PHYSICS. THESE INSTRUMENTS WILL BE REQUIRED TO DETECT AND ANALYZE NOT ONLY THE SPATIAL DISTRIBUTION BUT THE SPECTRAL FLUX DENSITY CHARACTERISTICS AS WELL. TO ACCOMPLISH THIS IT WILL BE NECESSARY TO DEFINE SPECIFIC SCIENTIFIC DATA REQUIREMENTS, DEVELOP INSTRUMENTATION SPECIFICATION, AND ESTABLISH DEVELOPMENT PROGRAMS TO INSURE THEIR TIMELY AVAILABILITY

RTOP NO. 188-78-54 TITLE: SOLAR ASTRONOMY/SPACECRAFT
ORGANIZATION: NASA HEADQUARTERS
MONITOR: AUCREMANNE, M. J. TEL. 202-962-1983
TECHNICAL SUMMARY

SPACEBORNE SOLAR ASTRONOMY TO BE OPTIMUMLY PURSUED, WILL REQUIRE THE TIMELY DEVELOPMENT OF SUITABLE SPACECRAFT CAPABLE OF ACCOMPLISHING THE UNIQUE REQUIREMENTS OF HIGH SPATIAL AND SPECTRAL RESOLUTION OF SOLAR PHENOMENA IN THE IR THROUGH X-RAY SPECTRUM. ADVANCED MISSIONS AND SPACECRAFT PARAMETERS FOR MANNED AND AUTOMATED OPERATIONS MUST BE DEVELOPED TO MEET SCIENTIFIC PROGRAM OBJECTIVES. CONCEPTUAL, FEASIBILITY, AND DEFINITION STUDIES MUST BE PERFORMED AND ADEQUATE REQUIREMENT SPECIFICATIONS DEVELOPED TO INSURE EFFECTIVE PROGRAM IMPLEMENTATION.

RTOP NO. 188-78-55 TITLE: SOLAR ASTRONOMY INSTRUMENTATION
ORGANIZATION: NASA HEADQUARTERS
MONITOR: AUCREMANNE, M. J. TEL. 202-962-1983
TECHNICAL SUMMARY

INSTRUMENTATION REQUIRED FOR ADVANCED SOLAR ASTRONOMICAL OBSERVATIONAL MISSIONS, IN ORDER TO MEET THE SCIENTIFIC PROGRAM OBJECTIVES, MUST BE CAPABLE OF PROVIDING INCREASINGLY HIGHER SPATIAL AND SPECTRAL RESOLUTION OF EXTREMELY TRANSIENT PHENOMENA IN THE IR THROUGH X-RAY SPECTRUM. THESE INSTRUMENTS WILL BE REQUIRED TO DETECT AND PRESENT THE TRANSIENT SPATIAL AND SPECTRAL FLUX DENSITY CHARACTERISTICS IN HIGH RESOLUTION. TO ACCOMPLISH THIS IT WILL BE NECESSARY TO DEVELOP TWO GENERIC CLASSES OF INSTRUMENTS. THE FIRST CLASS FOR THE IR THROUGH UV SPECTRUM WILL BE A HIGH RESOLUTION NORMAL INCIDENCE IMAGING SYSTEM WHILE THE SECOND WILL COVER THE SOFT TO MEDIUM X-RAY REGION AND WILL BE A NOMINAL RESOLUTION GRAZING INCIDENCE IMAGING SYSTEM. THIS WILL ALSO REQUIRE THE DEVELOPMENT OF SUITABLE ELECTRONIC IMAGE SENSING SYSTEMS IN THE ENTIRE SPECTRAL REGION TO BE COVERED.

RTOP NO. 188-78-56 TITLE: LARGE SPACE TELESCOPE/SPACECRAFT
ORGANIZATION: NASA HEADQUARTERS
MONITOR: AUCREMANNE, M. J. TEL. 202-962-1983
TECHNICAL SUMMARY

OPTIMUM PURSUIT OF SPACEBORNE ASTRONOMICAL OBSERVATIONS REQUIRE THE DEVELOPMENT OF SUITABLE SPACECRAFT CAPABLE OF PERMITTING THE COLLECTION OF HIGH RESOLUTION SPATIAL AND SPECTRAL DATA ON LOW INTENSITY STELLAR SOURCES IN THE INFRARED, VISIBLE, AND ULTRAVIOLET REGIONS OF THE SPECTRUM. UNIQUE REQUIREMENTS ASSOCIATED WITH ADVANCED SCIENTIFIC REQUIREMENTS NECESSITATES THE EVOLUTION OF NEW MISSION PARAMETERS WITH ADVANCED SPACECRAFT SPECIFICATIONS PERMITTING BOTH MANNED AND AUTOMATED OPERATIONS. CONCEPTUAL, FEASIBILITY, AND DEFINITION STUDIES MUST BE PERFORMED AND REQUIREMENTS SPECIFICATIONS DEVELOPED IN ORDER TO INSURE EFFECTIVE PROGRAM IMPLEMENTATION.

RTOP NO. 188-78-57 TITLE: LARGE SPACE TELESCOPE INSTRUMENTATION
ORGANIZATION: NASA HEADQUARTERS
MONITOR: AUCREMANNE, M. J. TEL. 202-962-1983
TECHNICAL SUMMARY

DEVELOPMENT OF THE LARGE SPACE TELESCOPE IS FUNDAMENTAL TO THE OBJECTIVES OF THE ASTRONOMY RESEARCH PROGRAM. IT IS ESSENTIAL THAT NORMAL INCIDENCE IMAGE FORMING SYSTEMS OPERATING WITH MAXIMUM SPATIAL AND SPECTRAL RESOLUTION IN THE IR, VISIBLE, AND ULTRA VIOLET REGIONS BE EVOLVED. THESE INSTRUMENTS WILL BE REQUIRED TO DETECT AND PRESENT ASTRONOMICAL DATA IN EXTREME FIDELITY. IN ORDER TO ACCOMPLISH THIS IT WILL BE NECESSARY TO DEVELOP A SERIES OF INSTRUMENTS THAT BOTH ACCOMPLISH THEIR SCIENTIFIC OBJECTIVE AND AT THE SAME TIME PROVIDE TECHNOLOGICAL DATA TO PERMIT A BURGEONING CAPABILITY. IN ORDER TO FULLY UTILIZE SUCH ADVANCED TELESCOPES IT WILL BE NECESSARY TO CONCURRENTLY DEVELOP SUITABLE ELECTRONIC IMAGE SENSING SYSTEMS.

RTOP NO. 195-42-50 TITLE: IMPACT CRATERING
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-1111
TECHNICAL SUMMARY

IMPACT CRATERING: THE VERTICAL GAS GUN RANGE WILL BE USED TO STUDY CRATERING IN UNCONSOLIDATED MATERIALS, MATERIALS OF LOW COHESIVE STRENGTH AND MASSIVE ROCK. STUDIES WILL BE MADE IN GRAVITY FIELDS OF FROM ONE TO ZERO. HIGH SPEED PHOTOGRAPHIC AND STEREOSCOPIC TECHNIQUES WILL BE USED TO STUDY CRATER FORMATION AND EJECTA THROW OUT TRAJECTORIES. TECHNIQUES THAT HAVE BEEN DEVELOPED WILL BE EXPLOITED TO MODEL AND STUDY OTHER GEOLOGICALLY SIGNIFICANT FORMATIONS FOR LUNAR (AND PLANETARY) APPLICATIONS. RESULTS OF STUDIES WILL BE COMBINED WITH RTOP 383 (NEW) "LUNAR DATA ANALYSIS" FOR INTERPRETATION OF THE LUNAR SURFACE MORPHOLOGY AND EVOLUTIONARY PROCESSES.

RTOP NO. 195-42-51 TITLE: METEORITES AND ABLATION PRODUCTS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-1111
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TWOFOLD: AN EXTENSION OF STUDIES OF THE CHEMISTRY AND MINERALOGY OF METEORITES AND ARTIFICIAL METEOR ABLATION; AND A NEW START IN ISOTOPE GEOCHEMISTRY AND COSMOGENIC NUCLIDES. A. A DETERMINATION WILL BE MADE OF ELEMENT CONCENTRATION AND DISTRIBUTIONS OF MAJOR AND MINOR ELEMENTS AMONG COEXISTING PHASES IN METEORITES. DISTRIBUTION COEFFICIENTS WILL BE CALCULATED FOR USE IN OBTAINING FORMATION TEMPERATURES AND OXYGEN FUGACITY ENVIRONMENTS. RESULTS OF THIS WORK WILL BE NEEDED FOR UNDERSTANDING FORMATION PROCESSES OF METEORITE PARENT BODIES. B. ARTIFICIAL ABLATION OF DIFFERENT SYNTHETIC AND NATURAL MATERIAL COMPARISONS WILL BE MADE BETWEEN THE ORIGINAL MATERIAL AND ITS ABLATION PRODUCTS IN THE SIZE

RANGE 0.1U AND LARGER. ANALYSES TO BE CONDUCTED ON SPECIMENS WILL INCLUDE: OPTICAL MINERALOGY, PETROGRAPHY, DENSITY, X-RAY DIFFRACTION, X-RAY FLUORESCENCE (LARGE SPECIMENS), AND ELECTRON MICROPROBE ANALYSIS (SMALL SPECIMENS). PARTICLES SMALLER THAN 1U WILL BE EXAMINED USING A SCANNING ELECTRON MICROSCOPE. C. A DETERMINATION OF THE ISOTOPIC COMPOSITION OF COEXISTING MINERALS IN METEORITES AND LUNAR MATERIALS IS TO BE ACCOMPLISHED BY USE OF AN ION MICROPROBE MASS ANALYZER. A FINE BEAM OF BOMBARDING IONS WILL BE USED TO SPUTTER-OFF SECONDARY IONS FROM SAMPLE SURFACES AND WILL BE ANALYZED BY MEANS OF A MASS SPECTROMETER. IN ADDITION TO ISOTOPIC COMPOSITION, THE HIGH SENSITIVITY OF THE MASS SPECTROMETER WILL ALLOW FOR ANALYSIS OF VARIOUS TRACE ELEMENTS IN BOTH METEORITIC AND LUNAR MATERIALS.

RTOP NO. 195-42-52 TITLE: TEKTITES; THEIR ORIGIN, DISTRIBUTION, AND PROPERTIES

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-1111

TECHNICAL SUMMARY

TO CONDUCT EXPERIMENTS AND THEORETICAL ANALYSES FOR DETERMINING THE PLACE OF ORIGIN, THE MECHANISM OF ORIGIN, AND THE MANNER OF GEOGRAPHICAL DISTRIBUTION OF AUSTRALASIAN TEKTITES, AND OCEANIC MICROTEKTITES. THE TEKTITES MAY PROVIDE DATA ON THE CHEMISTRY OF PORTIONS OF THE LUNAR UPLANDS AND INDIRECT INFORMATION ABOUT THE MOON'S PAST HISTORY. AUSTRALASIAN TEKTITES HAVE BEEN COLLECTED FROM MANY LOCALITIES AND CHEMICAL ANALYSES MADE TO DETERMINE THE GEOGRAPHIC DISTRIBUTION PATTERN. MOON-TO-EARTH TRAJECTORY STUDIES WERE MADE TO DETERMINE THE POSITION ON THE MOON THAT COULD BE THE SOURCE OF EJECTED MATERIAL THAT WOULD PRODUCE THE TEKTITE DISTRIBUTION PATTERN FOUND ON EARTH.

RTOP NO. 195-42-53 TITLE: ELECTROMAGNETIC RESONANCE AND BODY PROPERTIES OF THE MOON

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-1111

TECHNICAL SUMMARY

OBJECTIVES: A. TO ESTABLISH SCIENTIFIC ASPECTS OF THE MEASUREMENT OF THE ELECTRICAL PARAMETERS OF THE MOON FROM LUNAR ORBITAL AND SURFACE VEHICLES TO IDENTIFY MATERIALS AND TO OBTAIN ELECTROMAGNETIC PROFILING. B. TO DETERMINE MEANS OF MEASURING LUNAR INTERIOR PROPERTIES, AND TEMPERATURE PROFILES FROM STEADY STATE AND LOW FREQUENCY MEASUREMENTS OF THE ELECTROMAGNETIC RESPONSE OF THE MOON TO THE SOLAR WIND. C. TO OBTAIN THEORETICAL MODELS FOR THE ELECTRODYNAMICS RESPONSE OF THE MOON TO STEADY STATE AND LOW FREQUENCY ELECTRODYNAMIC STIMULI CAUSED BY THE IMMERSION OF THE MOON IN THE SOLAR WIND AND INTERPLANETARY MAGNETIC FIELD. D. TO CONDUCT THEORETICAL STUDIES ON THE EVOLUTION, COMPOSITION, AND STRUCTURE OF THE MOON AND OF METEORITE PARENT BODIES. THESE OBJECTIVES ARE PORTIONS OF THE GENERAL UNDERSTANDING OF THE INTERNAL PROPERTIES OF THE MOON AND OF ITS COMPOSITION AND TEMPERATURE PROFILES. THE

ANALYSES ARE THEORETICAL CALCULATIONS BASED ON KNOWN OR ASSUMED BOUNDARY (OR OTHER CONSTRAINT) CONDITIONS. MAXWELL'S EQUATIONS AND THERMODYNAMICS ARE EMPLOYED. VARIOUS MODELS OF THE MOON ARE IDENTIFIED AND USED. INTERNAL CONSISTENCY CHECKS ARE MADE, AND CONCLUSIONS ARE COMPARED WITH EXPERIMENTAL EVIDENCE WHENEVER POSSIBLE. IF EXPERIMENTAL INFORMATION IS NOT AVAILABLE, THE CONCLUSIONS SERVE AS BASES FOR DESIGN OF SUITABLE EXPERIMENTS FOR FLIGHT PROJECTS.

RTOP NO. 195-42-54 TITLE: LUNAR EXPLORATION PROGRAM SUPPORT

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BURKE, J. D. TEL. 213-354-6363

TECHNICAL SUMMARY

OBJECTIVE: TO ASSESS VARIOUS ASPECTS OF THE LUNAR EXPLORATION PROGRAM, TO RECOMMEND REDIRECTION WHERE APPROPRIATE, AND TO INITIATE APPROVED REDIRECTIONS. SUCH ASPECTS AS INVESTIGATION OF NEW EXPLORATION CONCEPTS AND INSTRUMENTATION HAVE BEEN TREATED DURING THE PAST YEAR AND WILL CONTINUE.

RTOP NO. 195-42-55 TITLE: GEOLOGY AND MINERALOGY

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BURKE, J. D. TEL. 213-354-6363

TECHNICAL SUMMARY

THE GEOLOGY AND MINERALOGY STUDY CONSISTS OF A COORDINATED PROGRAM OF EXPERIMENTAL AND THEORETICAL RESEARCH DIRECTED TOWARD UNDERSTANDING THE SURFACE AND SUBSURFACE PROPERTIES OF THE MOON AND DETERMINING THE EVOLUTIONARY HISTORY OF THE MOON AND ITS RELATION TO THE TERRESTRIAL PLANETS. THE TASKS CONSIST OF: (1) THE ANALYSIS OF LUNAR SURFACE STRUCTURE, (2) DETERMINATION OF SOLAR RADIATION EFFECTS ON THE OPTICAL AND PHYSICAL PROPERTIES OF THE LUNAR SURFACE, (3) STUDIES OF THE INFRARED AND MICROWAVE PROPERTIES OF ROCKS AND THEIR USE IN INTERPRETING TELESCOPIC AND SPACECRAFT OBSERVATIONS, AND (4) ANALYSIS OF ELECTROMAGNETIC SOUNDING TECHNIQUES FOR LUNAR SUBSURFACE EXPLORATION.

RTOP NO. 195-42-56 TITLE: LUNAR SCIENCE EXPERIMENTS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BURCHAM, D. P. TEL. 213-354-3028

TECHNICAL SUMMARY

INVESTIGATE NEW INSTRUMENT CONCEPTS. DEVELOP AND DEMONSTRATE THE CAPABILITIES OF INSTRUMENTS FOR SCIENTIFIC INVESTIGATIONS OF THE LUNAR ATMOSPHERE, SURFACE, AND SUBSURFACE TO DETERMINE CHARACTERISTICS AND COMPOSITION. IMPROVE THE TECHNIQUES OF ANALYSIS AND OF INTERPRETATION RELATED TO THE EXPLOITATION OF THE DATA FROM THESE INSTRUMENTS.

RTOP NO. 195-42-57 TITLE: PARTICLE TRACK COSMOCHRONOLOGY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THE METHOD OF PARTICLE TRACK COSMOCHRONOLOGY WILL BE IMPROVED IN ORDER TO GAIN NEW INFORMATION ABOUT THE ACCRETION TIME AND AGE OF THE MOON AND METEORITES. THE GEOCHEMISTRY OF THE ACTINIDE ELEMENTS, ESPECIALLY URANIUM, THORIUM AND PLUTONIUM, IN LUNAR METEORIC AND TERRESTRIAL ROCKS WILL BE EXPLORED. THIS IS PART OF THE COOPERATIVE PROGRAM WITH PROFESSOR G. WASSERBURG OF CALTECH AND WILL COVER THE SUPPORT OF DR. E. L. HAINES.

RTOP NO. 195-42-58 TITLE: LUNAR SCIENCE EXPERIMENTS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: DUDLEY, H. TEL. 205-453-2813
TECHNICAL SUMMARY

THIS RTOP SETS FORTH A PLANNED STUDY EFFORT TO DETERMINE THE FEASIBILITY OF A GRAVIMETER FOR LUNAR SURFACE OPERATION AND TO DEVISE A GRAVITY GRADIENT INSTRUMENT WITH SUFFICIENT SENSITIVITY FOR LUNAR ORBIT MISSIONS. OBJECTIVES WILL BE ACCOMPLISHED BY IN-HOUSE STUDIES AND CONTRACT STUDIES AND RELATED ANALYSIS WITH MSFC COORDINATION AND REQUIREMENT INPUT.

RTOP NO. 195-42-59 TITLE: GEOCHEMICAL RESEARCH OF LUNAR MATERIALS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: BRETT, P. R. TEL. 713-483-4757
TECHNICAL SUMMARY

GEOCHEMICAL RESEARCH OF LUNAR MATERIALS IS CHIEFLY A SCIENTIFIC RESEARCH EFFORT THAT WILL ACCUMULATE AND ANALYZE AVAILABLE INFORMATION AND WILL INITIATE AND CONDUCT ORIGINAL PROGRAMS OF RESEARCH AIMED AT GAINING A BETTER UNDERSTANDING OF LUNAR, TERRESTRIAL, AND PLANETARY GEOCHEMICAL EVOLUTION AND PROCESSES. THIS WILL INVOLVE PRECISE ANALYTICAL CHEMISTRY UTILIZING THE CAPABILITIES OF THE ANALYTICAL AND SYNTHETIC LABORATORIES OF THE LUNAR AND EARTH SCIENCES DIVISION. PROGRAMS OF RESEARCH WILL INCLUDE INVESTIGATIONS OF TERRESTRIAL MATERIALS TO UNDERSTAND THEIR CHEMICAL INTER-RELATIONSHIPS; WORK WITH METEORITES TO UNDERSTAND THEIR CHEMISTRY, MINERALOGY AND ORIGINS AS OUR ONLY PRESENT SAMPLES OF EXTRATERRESTRIAL MATERIALS OTHER THAN LUNAR SAMPLES; WORK WITH LUNAR SAMPLES THEMSELVES; RESEARCH ON THE EFFECTS AND MECHANISMS OF TERRESTRIAL AND LUNAR SURFACE WEATHERING; AND EXPERIMENTAL PETROLOGY TO TEST THE THEORIES OF PETROGENESIS. THE FUNCTION WILL SUPPORT THE GEOCHEMICAL EFFORTS OF THE LUNAR RECEIVING LABORATORY IN HANDLING OF LUNAR SAMPLES. PLANNED TASKS ARE LISTED ON THE NEXT PAGE.

RTOP NO. 195-42-60 TITLE: GEOPHYSICAL RESEARCH OF LUNAR MATERIALS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: GAST, P. W. TEL. 713-483-3261
TECHNICAL SUMMARY

GEOPHYSICAL RESEARCH OF LUNAR MATERIAL IS THAT EFFORT OF THE LUNAR AND EARTH SCIENCES DIVISION WHICH STUDIES THE PHYSICAL PROPERTIES OF THE EARTH & PLANETARY BODIES & PERFORMS GEOPHYSICAL RESEARCH ON THE ORIGIN AND PROPERTIES OF LUNAR MATERIALS. THIS EFFORT PROVIDES ADVICE TO OTHER ORGANIZATIONS, DOES BASIC GEOPHYSICAL RESEARCH, TESTS AND DEVELOPS EXPLORATION INSTRUMENTATION, INTERPRETS GEOPHYSICAL DATA AND GENERALLY REPRESENTS THE SCIENCE AND APPLICATION DIRECTORATE IN THE FIELD OF GEOPHYSICS. THE RESEARCH DUTIES ARE BASIC IN NATURE BECAUSE THERE IS A LACK OF CRITERIA FOR THE DEVELOPMENT OF TERRESTRIAL ANALOGS FOR PLANETARY GEOPHYSICAL STUDIES.

THE AREAS OF RESEARCH INTEREST ARE STUDIES IN SUCH FIELDS AS PHOTOMETRY, INFRARED EMISSION, SOIL MECHANICS, GEOMAGNETISM, AND SEISMOLOGY. THESE FIELDS PLUS THE APPROPRIATE FIELDS OF PALEOMAGNETISM, HEAT FLOW, AND EXPLORATION SEISMOLOGY WILL BE USED TO PROVIDE A PHYSICAL DESCRIPTION OF PLANETARY BODIES FROM ORBIT AND/OR FROM SURFACE EXPLORATION. TASKS WILL INCLUDE LABORATORY SIMULATION OF IR EMITTANCE AND ALSO OTHER OPTICAL PROPERTIES OF MINERALS AND DEVELOPMENT OF CONCEPTS FOR LUNAR GRAVITY AND ALSO SOIL MECHANICS TESTS.

RTOP NO. 195-42-61 TITLE: GEOLOGIC RESEARCH OF LUNAR MATERIALS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: GAST, P. W. TEL. 713-483-3261
TECHNICAL SUMMARY

GEOLOGIC RESEARCH IN THE LUNAR AND EARTH SCIENCES DIVISION ENTAILS ACCUMULATION AND ANALYSIS OF AVAILABLE DATA AND THE UNDERTAKING OF SCIENTIFIC RESEARCH PROGRAMS DEALING WITH THE ORIGIN AND EVOLUTION OF LUNAR, PLANETARY, AND TERRESTRIAL SURFACE FEATURES. THE RESEARCH PROJECTS WILL BE PRIMARILY FIELD ORIENTED, BUT WILL ALSO USE LABORATORY FACILITIES IN THE LUNAR AND EARTH SCIENCES DIVISION. TYPICAL RESEARCH PROGRAMS WILL BE THE STUDY OF TERRESTRIAL ANALOGS OF LUNAR SURFACE FEATURES, DETAILED STUDIES OF VOLCANIC STRUCTURES AND STRATIGRAPHY, AND INVESTIGATION INTO EXPLORATION TECHNIQUES APPLICABLE TO LUNAR (AND PLANETARY) SURFACES. INDIVIDUALS WILL BE ENCOURAGED TO PARTICIPATE AS INVESTIGATORS IN LUNAR (AND PLANETARY) EXPLORATION FLIGHT EXPERIMENTS.

RTOP NO. 195-42-62 TITLE: LUNAR SURFACE GEOCHEMICAL EXPERIMENTS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: ADLER, I. TEL. 301-982-5759
TECHNICAL SUMMARY

THE FOLLOWING STUDIES ARE ALL DIRECTED TOWARDS A PROGRAM OF LUNAR (AND PLANETARY) EXPLORATION. THE ACTIVITIES ARE VARIED, INVOLVING THE DEVELOPMENT OF INSTRUMENTATION AND TECHNIQUES FOR EITHER FLIGHT EXPERIMENT OR THE STUDY OF LUNAR MATERIALS. THE OBJECTIVES ARE AS FOLLOWS: A. TO EXAMINE THE VARIOUS TECHNIQUES AND INSTRUMENTS BEING

DEVELOPED IN OUR LABORATORY FOR USE AS COMPONENTS OF AN INTEGRATED GEOCHEMISTRY EXPERIMENT. THESE INVOLVE NEUTRON-GAMMA AND PASSIVE GAMMA TECHNIQUES, AND X-RAY AND MASS SPECTROSCOPY. THE PRIMARY PROBLEM IS THE DESIGN OF DATA HANDLING METHODS FOR THE COMBINED OUTPUT. B. THE APPLICATION OF AUGER AND PHOTOELECTRON SPECTROSCOPY TO THE STUDY OF MINERAL SYSTEMS. THE METHOD WILL BE APPLIED TO LUNAR SAMPLE STUDIES IN AN EFFORT TO DETERMINE THE VALENCE STATES OF CERTAIN KEY ELEMENTS SUCH AS IRON AND TITANIUM. SUCH STUDIES HAVE SOME BEARING ON DETERMINING CRYSTALLIZATION HISTORIES. C. THE STUDY OF THE RESPONSE FUNCTIONS OF DETECTORS TO GAMMA RADIATION AS A FUNCTION OF ENERGY. SUCH DETECTORS ARE SCHEDULED TO FLY ON APOLLO AND THE MARINER-MERCURY-VENUS FLIGHTS. D. DEVELOPMENT OF A COMPACT, RELIABLE X-RAY SPECTROMETER FOR ELEMENTAL ANALYSIS IN LUNAR (AND PLANETARY) EXPLORATION. E. DESIGN AND DEVELOP A MODULAR CENTRAL DATA ACCUMULATOR CAPABLE OF A NUMBER OF FUNCTIONS SUCH AS EXPERIMENT CONTROL, ACCUMULATION OF DATA AND FINALLY DATA TRANSMISSION IN APPROPRIATE FORMATS. THE DATA ACCUMULATOR WILL BE COMPATIBLE WITH A NUMBER OF EXPERIMENTS SUCH AS NEUTRON-GAMMA, PASSIVE GAMMA, X-RAY SPECTROSCOPY AND MASS SPECTROSCOPY.

RTOP NO. 195-42-63 TITLE: ORIGIN AND STRUCTURE OF THE MOON
 ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: WALTER, L. S. TEL. 301-982-2282

TECHNICAL SUMMARY

THE OBJECTIVE OF THE INHOUSE RESEARCH IS TO GAIN AN UNDERSTANDING OF THE NATURE AND ORIGIN OF THE CONDENSED MATTER OF THE SOLAR SYSTEM. MORE SPECIFICALLY, ACTIVITIES WILL FOCUS ON THE TIME AND MECHANISM OF FORMATION OF THE TERRESTRIAL PLANETS, THE MOON AND METEORITES AND SUBSEQUENT MODIFICATION OF THESE BODIES SINCE FORMATION. THIS INCLUDES, FOR EXAMPLE, DEVELOPMENT OF THE EARTH'S CORE AND FORMATION AND MOVEMENT OF THE CONTINENTS; DEVELOPMENT OF THE SURFICIAL TOPOGRAPHY OF THE MOON BY VULCANISM AND METEORITE/COMETARY IMPACT AND COMPARISON OF MAGNETIC DIFFERENTIATION PROCESSES OF THE MOON AND THE EARTH. THE APPROACH WILL BE MULTIDISCIPLINARY, INVOLVING THE FOLLOWING AREAS: 1. ANALYTICAL GEOCHEMISTRY - MAJOR, MINOR AND TRACE ELEMENT ANALYSIS 2. GEOCHRONOLOGY - RUBIDIUM/STRONTIUM AND POTASSIUM/ARGON AGE DETERMINATIONS 3. RADIOCHEMISTRY - DETERMINATION OF COSMIC-RAY SPALLATION PRODUCTS 4. MINERALOGY/PETROLOGY - MINERAL COMPOSITIONS AND TEXTURAL RELATIONS 5. CRYSTALLOGRAPHY - ANALYSIS OF CRYSTAL STRUCTURES 6. EXPERIMENTAL PETROLOGY - DUPLICATION OF NATURAL CONDITIONS IN THE LAB 7. GEOLOGIC INVESTIGATIONS - IN SITU (E.G., TERRESTRIAL CRATERS) AND PHOTOGRAPHS (E.G., LUNAR ORBITERS; EARTH SATELLITES) THE OBJECTIVES OF THE OUT-OF-HOUSE RESEARCH ARE: 1) TO DETERMINE THE STATE AND MAGNETIC MOMENT OF IRON IN TEKTITES AND METEORITES (ESPECIALLY ACHONDRITES) AND TO COMPARE THESE WITH LUNAR SAMPLES; 2) TO EVALUATE DIFFUSIVITY IN SILICATE MELTS WITH PARTICULAR APPLICATION TO THE FORMATION OF TEKTITES FROM THEIR (POSSIBLY HETEROGENOUS) PARENT MATERIALS; AND 3) SYNTHESIS OF EXTERNAL STRUCTURES (PITS AND GROOVES) OF TEKTITES IN ORDER TO ASCERTAIN THE CONDITIONS OF ENTRY OF TEKTITES IN THE TERRESTRIAL ATMOSPHERE.

RTOP NO. 195-42-64 TITLE: EARTH BASED OBSERVATIONS AND ANALOGUE STUDIES

ORGANIZATION: NASA HEADQUARTERS

MONITOR: BRYSON, R. P. TEL. 202-963-5367

TECHNICAL SUMMARY

THE OBJECTIVE OF THESE EARTH-BASED OBSERVATIONS AND STUDIES IS TO GAIN A CLEARER UNDERSTANDING OF THE LUNAR SURFACE PROCESSES BY ACQUIRING, ASSEMBLING, AND INTERPRETING DATA ON THE MOON AND ON EARTH FEATURES THAT MAY BE ANALOGOUS OF LUNAR FEATURES. THUS, A SOUND BASIS COULD BE PROVIDED FOR PLANNING AND CONDUCTING SPACECRAFT-BASED EXPERIMENTS TO INVESTIGATE THE MOON AND TO INTERPRET THE ADDITIONAL DATA THUS ACQUIRED. THIS WORK WILL BE ACCOMPLISHED BY CONDUCTING GEOLOGICAL STUDIES OF SELECTED TERRESTRIAL COUNTERPARTS, PATROLLING THE LUNAR SURFACE FOR TRANSIENT PHENOMENA, AND ANALYZING DATA OBTAINED FROM APOLLO, SURVEYOR, AND ORBITER MISSIONS FOR COMPARISON WITH EARTH-BASED VISUAL, PHOTOGRAPHIC, AND SPECTROSCOPIC TELESCOPIC OBSERVATIONS OF THE MOON. EARTH ANALOG STUDIES ARE PRIMARILY CONCERNED WITH THE NATURE AND ORIGIN OF TERRESTRIAL FEATURES IN VOLCANIC AND METEORITE IMPACT AREAS. TELESCOPIC OBSERVATIONS WERE A PRIMARY SOURCE OF DATA IN EARLY YEARS OF THIS WORK BUT ARE IN PART SUPPLANTED NOW BY SPACECRAFT-BASED EXPERIMENTS. CURRENTLY THIS PROGRAM IS BEING CARRIED OUT THROUGH THE EFFORTS OF GOVERNMENT LABORATORIES, SEVERAL UNIVERSITY GROUPS, AND NASA CENTERS. THE SUBPROGRAM FUNDING UNDER THIS RTOP IS PLANNED FOR SEVERAL UNIVERSITIES.

RTOP NO. 195-42-65 TITLE: THEORETICAL STUDIES AND LAB SIMULATION

ORGANIZATION: NASA HEADQUARTERS

MONITOR: BRYSON, R. P. TEL. 202-963-5367

TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE SCIENTIFIC CONCEPTS, SUPPORTED BY LABORATORY SIMULATION, BEARING ON THE NATURE AND ORIGIN OF THE MOON AS A PLANETARY BODY AND ALSO OF ITS INDIVIDUAL FEATURES, THUS PROVIDING A CONSISTENT, IMAGINATIVE BUT INCREASINGLY RELIABLE, BASIS FOR EXPLORATION PLANNING AND SUBSEQUENT DATA ANALYSIS. CLEARLY, THIS IS AN ITERATIVE PROCESS INVOLVING THEORY, SIMULATION AND DATA ANALYSIS. THIS WORK IS BEING CARRIED OUT THROUGH THE EFFORTS OF GOVERNMENT AND INDUSTRIAL LABORATORIES, AND NUMEROUS NOT-FOR-PROFIT AND UNIVERSITY GROUPS IN ADDITION TO NASA CENTERS. INTEREST IN RESEARCH IN THIS AREA IS LIMITED PRIMARILY BY AVAILABILITY OF FUNDS. IT IS STIMULATED BY SCIENTIFIC CURIOSITY AND PROMPTED BY A DESIRE TO JUSTIFY DIVERSE ACTIVITIES AS PERTINENT TO LUNAR STUDY. MAJOR AREAS OF INTEREST INCLUDE: PROBLEMS OF COSMO GENESIS, ELEMENTAL, MINERALOGIC AND PHYSICAL FORM AND DISTRIBUTION WITHIN THE MOON, TEMPERATURE AND PRESSURE GRADIENTS AND EFFECTS, ENVIRONMENTAL CONDITIONS AND IMPACT ON THE LUNAR SURFACE, IMPACTING BODIES AND VOLCANIC PROCESSES, ETC. AFTER REJECTING PROPOSALS FOR RESEARCH THAT IS NOT TIMELY OR THAT CAN NOT BE EXPECTED TO PROVIDE SIGNIFICANT AND/OR CONCLUSIVE RESULTS, WE HAVE A GROWING RESEARCH PROGRAM IN THIS AREA TO SUPPORT EXPERIMENT DEVELOPMENT AND DATA ANALYSIS.

RTOP NO. 195-42-66 TITLE: SCIENCE EXPERIMENT CONCEPTS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: BRYSON, R. TEL. 202-963-5367
TECHNICAL SUMMARY

THE OBJECTIVE IS TO CONCEIVE AND EVOLVE EXPERIMENT CONCEPTS AND TO DEVELOP AND DEMONSTRATE EXPERIMENTS THAT COULD BE CONDUCTED IN LUNAR (OR PLANETARY) ORBIT ON THE LUNAR (OR PLANETARY) SURFACE. THIS REQUIRES PERFECTION OF THE TECHNIQUES OF DATA REDUCTION AND ANALYSIS AND INTERPRETATION AS WELL AS INVESTIGATIONS OF NEW CONCEPTS, INSTRUMENTS, AND HARDWARE, INCLUDING TESTING AND CALIBRATION. THESE EXPERIMENTS EMPHASIZE GEOPHYSICS AND GEOCHEMISTRY. TASKS ARE INCLUDED IN THE FOLLOWING AREAS: EVALUATIONS FOR POSSIBLE ACTIVE/PASSIVE SEISMIC EXPERIMENTS, EVALUATIONS OF FUTURE GEOCHEMICAL LUNAR SURFACE EXPERIMENTS, STUDY OF LUNAR TRAVERSE GEOPHYSICS, SPECTRAL REFLECTANCE OF THE LUNAR SURFACE STUDIES, COMBINED PULSED NEUTRON EXPERIMENT, NEUTRON X-RAY DIFFRACTOMETERS USING RADIOACTIVE SOURCES, LUNAR ATMOSPHERIC MASS SPECTROMETER, COMPARATIVE TESTS OF LUNAR ATMOSPHERIC MASS SPECTROMETERS, ORBITAL ELECTROMECHANICAL SOUNDER EXPERIMENT, LUNAR SOIL MECHANICAL PROPERTIES STUDIES, TRAVERSE GRAVIMETER, TECHNIQUES FOR DETERMINING LUNAR SURFACE VERTICAL ELEVATION, LUNAR ORBIT GRAVITY GRADIENT EXPERIMENT, LUNAR SURFACE OPTICAL ENVIRONMENT EXPERIMENT, LUNAR SEISMIC AMPLIFIER IMPROVEMENT, MICROWAVE RADIOMETER, LUNAR NEUTRON ALBEDO EXPERIMENT, LUNAR STRAIN METER AND A HOLOGRAPHIC CAMERA.

RTOP NO. 195-42-67 TITLE: EXTRATERRESTRIAL MATERIALS STUDIES
ORGANIZATION: NASA HEADQUARTERS, CODE MAL
MONITOR: PONEROY, J. H. TEL. 202-963-7831
TECHNICAL SUMMARY

THE OBJECTIVE OF EXTRATERRESTRIAL MATERIALS STUDIES IS TO IMPROVE, AND EXTEND SCIENTIFIC AND TECHNICAL KNOWLEDGE OF METEORITES, IN ORDER TO INCREASE OUR UNDERSTANDING OF THE COMPOSITION AND HISTORY OF THE SOLAR SYSTEM. METEORITES CAN ALSO GIVE US DETAILED INFORMATION ON PRESENT AND PAST CONDITIONS OF COSMIC RADIATION IN INTERPLANETARY SPACE, AND SO CAN SERVE AS SPACE PROBES. STUDIES OF SUCH MATERIAL AS METEORITES AND TEKTITES ARE ALSO VALUABLE SUPPLEMENTS TO STUDIES OF THE CHEMICAL, PHYSICAL, AND GEOLOGICAL PROPERTIES OF THE LUNAR SAMPLES; TECHNIQUES FIRST DEVELOPED FOR THESE STUDIES HAVE BEEN VERY SUCCESSFULLY EXTENDED TO STUDIES OF THE LUNAR SAMPLES. MUCH EXTRATERRESTRIAL INFORMATION IS AVAILABLE FROM METEORITES NOT AVAILABLE IN ANY OTHER WAY. A WIDE VARIETY OF EXPERIMENTAL TECHNIQUES ARE AVAILABLE FOR METEORITE STUDY, INCLUDING MEASUREMENTS IN CRYSTALLOGRAPHY, MINERALOGY, RADIOACTIVITY, PARTICLE TRACKS, CHEMICAL AND ISOTOPIC COMPOSITION, ETC.; THESE ALL SERVE TO GIVE US DETAILED INFORMATION ON THE ORIGIN, AGE, AND HISTORY OF THESE EXTRATERRESTRIAL OBJECTS.

RTOP NO. 195-43-50 TITLE: LUNAR LASER RANGING EXPERIMENT
ORGANIZATION: NASA HEADQUARTERS
MONITOR: STRICKLAND, A. T. TEL. 202-962-4091
TECHNICAL SUMMARY

THIS RTOP PROVIDES FOR THE CONDUCT OF THE LUNAR LASER RANGING EXPERIMENT. ACTIVITIES INCLUDE (1) THE MONITORING OF POINT-TO-POINT DISTANCES BETWEEN STATIONS ON THE MOON AND THE EARTH BY THE TECHNIQUE OF SHORT-PULSE LASER RANGING. (2) IMPROVING CURRENT LASER AND TIMING TECHNIQUES TO ACQUIRE MEASUREMENTS OF PLUS OR MINUS 1 NSEC. (3) ANALYSING THE RANGING DATA TO STUDY THE LUNAR PHYSICAL LIBRATIONS, CENTER-OF-MASS MOTION, SECULAR VARIATION IN THE GRAVITATIONAL CONSTANT, AND THE EARTH MOTION RATE, MOTION OF THE POLES AND CONTINENTAL DRIFT. RANGING PROGRAMS ARE CURRENTLY BEING CONDUCTED AT THE MCDONALD OBSERVATORY, TEXAS AND AT THE CATALINA STATION, ARIZONA.

AN ADDITIONAL STATION IS PROPOSED FOR HALEAKALA, HAWAII. INTERNATIONAL PARTICIPATION IS BEING EXPLORED FOR OTHER GEOGRAPHICAL LOCATIONS THAT WOULD MAKE SIGNIFICANT CONTRIBUTIONS TO THE RANGING EXPERIMENT. THIS EFFORT WILL IMPROVE OUR KNOWLEDGE OF THE EARTH-MOON DISTANCE, ECCENTRICITY OF LUNAR ORBIT, LUNAR ROTATION MOTIONS, EARTH ROTATION RATE, WOBBLE AND INTERCONTINENTAL DRIFT.

RTOP NO. 196-41-50 TITLE: GROUND-BASED INFRARED ASTRONOMY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: HANEL, R. A. TEL. 301-982-4528
TECHNICAL SUMMARY

THE SCIENTIFIC OBJECTIVE IS TO MEASURE THE THERMAL EMISSION SPECTRUM OF VENUS, MARS, JUPITER, AND POSSIBLY SATURN, WITH A SPECTRAL RESOLUTION ADEQUATE TO RESOLVE MOLECULAR LINES AND TO USE THESE SPECTRA IN THE STUDY OF THE COMPOSITION AND THERMAL STRUCTURE OF THE ATMOSPHERES. THIS GOAL WILL BE ACCOMPLISHED BY THE USE OF A DOUBLE BEAM MICHELSON INTERFEROMETER CAPABLE TO RESOLVE 0.2 WAVE NUMBERS BETWEEN 7 AND 25 MICRONS. THE INSTRUMENT WILL BE ATTACHED TO THE COUDE FOCUS OF A LARGE GROUND-BASED TELESCOPE.

RTOP NO. 196-41-51 TITLE: RADIO AND RADAR PLANETARY STUDIES
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: ALEXANDER, J. K. TEL. 301-982-5461
TECHNICAL SUMMARY

THE OBJECTIVE OF THE JUPITER MONITOR PROGRAM IS TO OBTAIN CONTINUOUS SYNOPTIC OBSERVATIONS OF THE DECAMETER-WAVE RADIO EMISSIONS FROM JUPITER IN ORDER TO FACILITATE RELIABLE STUDIES OF THE MORPHOLOGY OF THE EMISSION PHENOMENON AND ITS RELATION TO DYNAMICAL PROCESSES IN THE JOVIAN MAGNETOSPHERE. TO MEET THIS NEED A WORLD-WIDE NETWORK OF FIVE OBSERVING SITES HAS BEEN ESTABLISHED IN ORDER TO MONITOR JUPITER WITH IDENTICAL INSTRUMENTS AT EACH SITE AND THUS OBTAIN A HOMOGENEOUS BODY OF DATA FOR ANALYSIS. EACH SITE CONSISTS OF A TWO-ELEMENT INTERFEROMETER OPERATING AT 16.7 AND 22.2

MHZ. THESE ARE LOCATED AT GODDARD SPACE FLIGHT CENTER, AT CLARK LAKE OBSERVATORY IN BORREGO SPRINGS, CALIF., AND AT MSFN STATIONS IN KAUAI, HAWAII; CARNARVON, AUSTRALIA; AND GRAND CANARY IS., SPAIN. THE NETWORK IS PROVIDING IMPORTANT DATA ON THE JOVIAN RADIO EMISSIONS THAT CAN NOT BE OBTAINED FROM A SINGLE, ISOLATED OBSERVATORY OR FROM COMBINATION OF DATA FROM VARIOUS DISIMILAR OBSERVATORIES.

RTOP NO. 196-41-66 TITLE: AIRBORNE PLANETARY ASTRONOMY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-1111
TECHNICAL SUMMARY

THIS RTOP IS TO PROVIDE HIGH-ALTITUDE PLATFORMS FOR INFRARED OBSERVATIONS OF THE PLANETS. THE EXPERIMENTS WILL BE FLOWN AT ALTITUDES WHICH PUT THEM ABOVE MOST OF THE ATMOSPHERIC WATER VAPOR, WHICH IS THE CHIEF ABSORBER OF INFRARED RADIATION. THIS PROGRAM OF AIRBORNE PLANETARY RESEARCH WILL PROVIDE MUCH NEEDED INFORMATION ON THE EXTENT AND COMPOSITION OF PLANETARY ATMOSPHERES AND THE COMPOSITION OF PLANETARY SURFACES. THIS INFORMATION WILL BE OF ASSISTANCE IN THE DESIGN OF MANNED AND UNMANNED SYSTEMS FOR MISSIONS TO THE PLANETS.

RTOP NO. 196-41-67 TITLE: PLANETARY ASTRONOMY - SUPPORTING
LABORATORY STUDIES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-1111
TECHNICAL SUMMARY

THE ABUNDANCE, TEMPERATURE, AND PRESSURE OF CERTAIN CONSTITUENTS OF PLANETARY ATMOSPHERES CAN BE DETERMINED BY SPECTROSCOPIC OBSERVATIONS FROM GROUND-BASED AND FROM AIRBORNE OBSERVATORIES. SUCH DATA IS NECESSARY FOR THE PREPARATION OF MODEL ATMOSPHERES THAT ARE NEEDED TO EVALUATE THE POSSIBILITIES OF LIFE ON THE PLANET AND TO DESIGN SYSTEMS FOR EXPLORATORY MISSIONS. THE OBJECTIVE OF THIS WORK IS TO MAKE SUCH OBSERVATIONS (OR USE OBSERVATIONS MADE BY OTHERS), TO OBTAIN THE LABORATORY-DERIVED VALUES OF SPECTROSCOPIC PARAMETERS NEEDED TO ANALYZE OBSERVATORY SPECTRA, AND TO DEVELOP THE ANALYTICAL AND COMPUTATIONAL TECHNIQUES NEEDED TO INTERPRET THE SPECTRA IN TERMS OF REAL PLANETARY ATMOSPHERES.

RTOP NO. 196-41-71 TITLE: GROUND BASED OPTICAL ASTRONOMY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS THE COMPREHENSIVE STUDY OF ATMOSPHERES AND SURFACES OF SOLAR SYSTEM BODIES THROUGH GROUND-BASED TELESCOPIC OBSERVATIONS. PRINCIPAL EMPHASIS IN THIS PROGRAM IS DEVOTED TO SPECTROSCOPIC OBSERVATIONS OF MARS, VENUS AND JUPITER. ALL AVAILABLE EARTH-BASED TECHNIQUES SHOULD BE USED TO LEARN AS MUCH AS POSSIBLE ABOUT A PLANETARY ATMOSPHERE BEFORE A SPACE MISSION AND

ITS COMPLEMENT OF SCIENTIFIC INSTRUMENTS IS PLANNED. DATA ACQUIRED FROM THE EARTH COMPLEMENTS THE TYPE OF INFORMATION NORMALLY ACQUIRED FROM SPACECRAFT. THE BASIC INSTRUMENT BEING USED IN THIS TASK IS THE HIGH-DISPERSION COUDE SPECTROGRAPH AT THE COUDE FOCUS OF THE TABLE MOUNTAIN OBSERVATORY 24-INCH TELESCOPE. IMMEDIATE OBJECTIVES FOR FY'71 ARE ANALYSIS OF THE 6800 A METHANE BAND IN THE SPECTRUM OF JUPITER, SEARCH FOR A POSSIBLE PHASE EFFECT IN THE CO₂ LINES IN THE SPECTRUM OF VENUS AND INITIATION OF A SPECTROSCOPIC PATROL TO MEASURE THE AMOUNT AND SEASONAL VARIATION OF WATER VAPOR IN THE MARTIAN ATMOSPHERE.

RTOP NO. 196-41-72 TITLE: GROUND BASED INFRARED ASTRONOMY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO OBTAIN AND ANALYZE HIGH RESOLUTION SPECTRA OF THE ATMOSPHERES OF THE PLANETS AT INFRARED WAVELENGTHS. THE MAIN INSTRUMENT INVOLVED IS THE MK III PLANETARY INTERFEROMETER WHICH OPERATES A CONTINUING PROGRAM OF PLANETARY OBSERVATIONS AT THE 107" TELESCOPE, MCDONALD OBSERVATORY. SPECIFIC OBJECTIVES FOR FY'71 ARE IMPROVED SPECTRA OF MARS, VENUS AND JUPITER IN THE 1.2 TO 5 MICRON REGION. A SECOND INSTRUMENT, NOW UNDER CONSTRUCTION, IS INTENDED AS AN ATTACHMENT TO THE TABLE MOUNTAIN COUDE SPECTROGRAPH. IT IS A FABRY-PEROT INTERFEROMETER AND ITS PURPOSE IS TO OBTAIN EXTREME RESOLUTION IN ORDER TO STUDY LINE PROFILES IN PLANETARY ATMOSPHERES. A SECONDARY OBJECTIVE OF THIS TASK IS TO ACQUIRE AND ANALYZE SOLAR AND STELLAR SPECTRA, IN ORDER TO FULLY UNDERSTAND THE INSTRUMENT AND INTERPRET PLANETARY SPECTRA, AS WELL AS FOR ITS SCIENTIFIC SIGNIFICANCE.

RTOP NO. 196-41-73 TITLE: RADIO AND RADAR PLANETARY STUDIES AND
INSTRUMENTATION DEVELOPMENT
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO CONDUCT A COMPREHENSIVE PROGRAM IN GROUND BASED PLANETARY RADIO ASTRONOMY. SOME SPECIFIC RADAR ASTRONOMY PROGRAMS WILL ALSO BE CARRIED OUT UNDER THIS TASK. THE INFORMATION AVAILABLE THROUGH RADIO ASTRONOMICAL MEASUREMENTS RANGES FROM BRIGHTNESS TEMPERATURES OF PLANETARY SURFACES AND ATMOSPHERES, TO INFORMATION ABOUT THE NATURE OF IONOSPHERES AND RADIATION BELTS. THE TECHNIQUE MAY PROVIDE INFORMATION ABOUT MOLECULAR SPECIES PRESENT IN THE UPPER ATMOSPHERES OF THE PLANETS. RADAR ASTRONOMY PROVIDES DATA ON THE PROPERTIES ON THE ATMOSPHERES, SURFACES, AND MECHANICS OF THE BODIES OF THE SOLAR SYSTEM. EQUIPMENT USED IN THE COURSE OF THIS TASK INCLUDES THE FACILITIES AND TEST EQUIPMENT OF THE TABLE MOUNTAIN OBSERVATORY AND THE DEEP SPACE NETWORK. THE FACILITIES INCLUDE THE 18-FOOT MILLIMETER WAVE ANTENNA AT TABLE MOUNTAIN, AND THE 30-FOOT, 85-FOOT, AND 210-FOOT ANTENNAS AT THE GOLDSTONE TRACKING STATION. A RADIOMETER DEVELOPMENT PROGRAM IS CONDUCTED IN CONJUNCTION WITH THE

SPECIFIC NEEDS OF THE RADIO ASTRONOMY PROGRAM. THEORETICAL AND EXPERIMENTAL MICROWAVE SPECTROSCOPIC TECHNIQUES WILL BE USED TO PROVIDE SPECTROSCOPIC INFORMATION REQUIRED FOR THE PLANNING OF EXPERIMENTS AND THE INTERPRETATION OF THE RESULTS. A MICROWAVE SPECTROMETER, BUILT UNDER NASA UNIT 129-02-06-01-55 FOR FREE RADICAL INVESTIGATIONS, WILL BE USED IN THE STUDY.

RTOP NO. 196-41-74 TITLE: PLANETARY ASTRONOMY--SUPPORTING
LABORATORY STUDIES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BURCHAM, D. P. TEL. 213-354-3028

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS ACTIVITY IS TO SUPPORT ASTRONOMICAL AND SPACE FLIGHT STUDIES OF PLANETARY ATMOSPHERES BY OBTAINING SPECTRA OF GASES UNDER SUITABLE CONDITIONS. THERE ARE TWO MAIN FUNCTIONS, NAMELY: (1) TO FURNISH QUANTITATIVE BAND OR LINE DATA CHIEFLY AT INFRARED WAVELENGTHS, AND (2) TO PROVIDE DIRECT AID IN VERIFYING IDENTIFICATIONS OF FEATURES OBSERVED IN PLANETARY SPECTRA. THE PRIMARY FACILITY EMPLOYED IN THIS TASK IS THE SPECTROSCOPY LABORATORY WHICH CONTAINS SPECTROMETERS COVERING THE VISIBLE, NEAR AND MIDDLE INFRARED SPECTRAL REGIONS AND ABSORPTION TUBES CAPABLE OF PROVIDING PATH LENGTHS OF UP TO 1 KILOMETER AT ANY PRESSURE. AN AEROSOL CHAMBER FOR THE STUDY OF LINE FORMATION IN SCATTERING ATMOSPHERES HAS ALSO BEEN CONSTRUCTED.

RTOP NO. 196-41-80 TITLE: GROUND-BASED OPTICAL PLANETARY ASTRONOMY

ORGANIZATION: NASA HEADQUARTERS

MONITOR: BRUNK, W. E. TEL. 202-962-1216

TECHNICAL SUMMARY

THE OBJECTIVE IS TO STUDY THE PLANETS THROUGH ASTRONOMICAL OBSERVATIONS IN THE VISIBLE AND NEAR INFRARED REGIONS OF THE SPECTRUM USING INSTRUMENTS LOCATED AT GROUND-BASED OBSERVATORIES. REDUCTION, INTERPRETATION, AND ANALYSIS OF THE DATA THUS OBTAINED ARE INCLUDED.

RTOP NO. 196-41-81 TITLE: ASTRONOMICAL OPTICAL INSTRUMENT
DEVELOPMENT

ORGANIZATION: NASA HEADQUARTERS

MONITOR: BRUNK, W. E. TEL. 202-962-1216

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO DESIGN, DEVELOP, AND CONSTRUCT OPTICAL INSTRUMENTATION TO BE USED FOR ASTRONOMICAL OBSERVATIONS. INCLUDED ARE BOTH MAJOR ITEMS SUCH AS TELESCOPES AND AUXILIARY EQUIPMENT SUCH AS CAMERAS, PHOTOMETERS, SPECTROMETERS, INTERFEROMETERS, ETC.

RTOP NO. 196-41-82 TITLE: GROUND-BASED RADIO AND RADAR PLANETARY
ASTRONOMY

ORGANIZATION: NASA HEADQUARTERS

MONITOR: BRUNK, W. E. TEL. 202-962-1216

TECHNICAL SUMMARY

THE OBJECTIVE IS TO DETERMINE PLANETARY PROPERTIES BY
OBSERVATIONS FROM GROUND-BASED OBSERVATORIES AT RADIO WAVELENGTHS.
BOTH PASSIVE (RADIO) AND ACTIVE (RADAR) OBSERVATIONS WILL BE
PERFORMED. THE PROGRAM WILL INCLUDE THE REDUCTION, ANALYSIS, AND
INTERPRETATION OF THE OBSERVATIONS.

RTOP NO. 196-41-83 TITLE: RADIO AND RADAR ASTRONOMY INSTRUMENT
DEVELOPMENT

ORGANIZATION: NASA HEADQUARTERS

MONITOR: BRUNK, W. E. TEL. 202-962-1216

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO DESIGN, DEVELOP, AND
CONSTRUCT INSTRUMENTS TO BE USED FOR RADIO AND RADAR ASTRONOMY, WITH
EMPHASIS ON PLANETARY ASTRONOMY. THE PROGRAM WILL INCLUDE AUXILIARY
INSTRUMENTATION FOR EXISTING RADIO AND RADAR FACILITIES AS WELL AS
MAJOR FACILITIES WHEN REQUIRED.

RTOP NO. 196-41-84 TITLE: LABORATORY SUPPORTING STUDIES (ASTRONOMY)

ORGANIZATION: NASA HEADQUARTERS

MONITOR: BRUNK, W. E. TEL. 202-962-1216

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO OBTAIN LABORATORY DATA
REQUIRED FOR THE ANALYSIS AND INTERPRETATION OF PLANETARY
OBSERVATIONS MADE FROM THE VICINITY OF THE EARTH. THE DATA OBTAINED
WILL BE OF TWO TYPES, FIRST, DETAILED STUDY OF GASES AND OTHER
MATERIALS KNOWN TO EXIST ON A PLANET AND, SECOND, STUDY OF THE
PROPERTIES OF MANY POSSIBLE MATERIALS TO TRY TO EXPLAIN UNIDENTIFIED
FEATURES DETECTED IN PLANETARY OBSERVATIONS. THE DATA OBTAINED UNDER
THIS PROGRAM WILL BE PUBLISHED AS WELL AS BEING USED DIRECTLY IN THE
INTERPRETATION OF NEW OBSERVATIONS.

RTOP NO. 196-41-85 TITLE: THEORETICAL PLANETARY ASTRONOMY

ORGANIZATION: NASA HEADQUARTERS

MONITOR: BRUNK, W. E. TEL. 202-962-1216

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO SUPPORT THE PLANETARY
ASTRONOMY PROGRAM BY PREDICTING WHAT THE OBSERVATIONAL DATA SHOULD
LOOK LIKE AND BY EXPLAINING UNPREDICTED OBSERVATIONAL RESULTS. THIS
PROGRAM IS AN IMPORTANT LINK BETWEEN THE OBSERVATIONAL PROGRAM AND AN
UNDERSTANDING OF THE PLANETS.

RTOP NO. 320-01-02 TITLE: SPACE TECHNOLOGY APPLICATIONS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-1111
TECHNICAL SUMMARY

(1) A STUDY WILL BE MADE TO DEVISE METHODS FOR THE PRACTICAL AND ECONOMICAL DISPOSAL OF SOLID REFUSE. THE PURPOSE IS TO MINIMIZE THE PROBLEM OF SOLID WASTE DISPOSAL AND TO EFFECTIVELY USE REFUSE TO PROVIDE FUEL. (2) POLLUTION CONTROL OF GASOLINE POWERED ENGINES WILL BE STUDIED WITH THE OBJECTIVE TO DEVELOP A SYSTEM WHICH WOULD MINIMIZE OR ELIMINATE ENGINE EXHAUST POLLUTANTS. (3) FIRE RETARDANT FOAMS, BOTH FLEXIBLE AND RIGID, WILL BE DEVELOPED AS NEW GENERATION FOAMS OR MODIFIED FROM EXISTING SYSTEMS OF 51 COMPOSITE AND POLYISOCYANURATE LOW DENSITY FOAMS TO REDUCE SMOKE PRODUCTION, FLAME SPREAD, AND TOXICITY DURING A FIRE. EFFECTIVENESS OF THESE SYSTEMS TO SUPPRESS FIRES AND PROTECT EQUIPMENT AND PERSONNEL FROM FIRE HAZARDS WILL BE EVALUATED. (4) INSTRUMENTATION, DEVICES, AND SENSORS DEVELOPED FOR OTHER NASA PURPOSES WILL BE ADAPTED TO APPLICATIONS REQUIRED BY OTHER AGENCIES.

RTOP NO. 320-01-04 TITLE: SPACE TECHNOLOGY APPLICATIONS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

SEVERAL EXHAUST POLLUTANTS, SUCH AS NITRIC AND SULPHURIC OXIDES, WILL POISON URBAN AIR BY FORMING ACID VAPORS WHEN IN CONTACT WITH WET AIR MASSES. TODAY'S TECHNOLOGY IN TRACE GAS ANALYSIS PROVIDES INSTRUMENTATION RESPONSIVE TO ALMOST ALL ATMOSPHERIC CONSTITUENTS SIMULTANEOUSLY. MSFC'S CROSSED-BEAM TECHNOLOGY CAN: (1) MAKE IT POSSIBLE TO INITIALLY STUDY THE LOCAL DISPERSION AND MASS FLUX OF PARTICULATE POLLUTION OF COMBUSTION EXHAUST PRODUCTS AND (2) INITIATE THE DEVELOPMENT OF METHODOLOGY TO MONITOR THE LOCAL GENERATION, DISPERSION AND CONDENSATION OF THE ACID PRODUCING POLLUTANT COMPOUNDS.

RTOP NO. 320-01-05 TITLE: SPACE TECHNOLOGY APPLICATIONS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: SPENCER, D. F. TEL. 213-354-6852
TECHNICAL SUMMARY

JPL WILL APPLY SPACE-DERIVED CAPABILITIES TO THE RESOLUTION OF PROBLEMS AND OTHERS OF NATIONAL INTEREST, PARTICULARLY THOSE RELATING TO THE CIVIL SYSTEMS AREAS INCLUDING PUBLIC SAFETY SUPPORT, MEDICAL ENGINEERING, AND OTHERS. SPACE-DERIVED CAPABILITIES INCLUDE EXPERIENCE AND TECHNOLOGY THAT IS APPLICABLE IN: 1) PROJECT AND SYSTEMS MANAGEMENT. 2) SYSTEMS ANALYSIS AND PROJECT ENGINEERING. 3) SPECIALIZED TECHNICAL DISCIPLINES (E.G., COMMUNICATIONS, GUIDANCE, PROPULSION, ETC.) 4) DESIGN, OPERATION AND EVALUATION OF COMPLEX TEST PROGRAMS. FROM THE CIVIL SYSTEMS AREAS JPL WILL (1) IDENTIFY AND ANALYZE PROBLEMS, (2) DETERMINE REQUIREMENTS, (3) APPLY A SYSTEMS APPROACH, (4) SELECT A MIX OF TASKS APPROPRIATE TO CAPABILITY AND EMPHASIZING THE APPLICATION OF SPACE TECHNOLOGY, AND (5) CONCENTRATE ON MAKING FEASIBLE HARDWARE DEMONSTRATIONS THAT WILL

HELP INTERESTED GOVERNMENT AGENCIES AND/OR INDUSTRIAL COMPANIES IN SOLVING PROBLEMS THAT ARE NATIONAL IN SCOPE.

RTOP NO. 320-01-06 TITLE: AEROSPACE TECHNOLOGY APPLICATIONS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO SELECTIVELY APPLY AEROSPACE TECHNOLOGY TO ASSIST THE DOD AND OTHER AGENCIES IN SOLVING PROBLEMS AFFECTING THE MILITARY AND MODERN SOCIETY.

RTOP NO. 320-01-07 TITLE: LONG RANGE LASER TRAVERSING SYSTEM
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: CAUDILL, L. O. TEL. 301-982-4969

TECHNICAL SUMMARY

THIS RTOP IS FOR DEVELOPMENT OF A LIGHTWEIGHT, BACKPACKED PROTOTYPE LASER SYSTEM AND FOR PERFORMING FIELD EVALUATION EXPERIMENTS TO DETERMINE THE FEASIBILITY OF ESTABLISHING PRECISE LINE OF SIGHT USING THE SCATTERED LASER LIGHT FROM A DISTANCE VERTICALLY POINTED LASER. THIS WORK IS A DIRECT APPLICATION OF OPTICAL TECHNOLOGY DEVELOPED UNDER OART PROGRAM AND WILL PROVIDE THE U. S. FOREST SERVICE WITH A SURVEYING TECHNIQUE THAT WILL SAVE A GREAT DEAL OF TIME AND MONEY.

RTOP NO. 320-01-10 TITLE: EXPANDED APPLICATIONS OF FIRE RESISTANT
NONMETALLIC MATERIALS

ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: RADNOFSKY, M. I. TEL. 713-483-3343

TECHNICAL SUMMARY

SELECTIVELY APPLY AEROSPACE TECHNOLOGY TO SOLUTIONS OF FIRE PROBLEMS IN MODERN SOCIETY.

RTOP NO. 384-47-81 TITLE: DATA ANALYSIS - PLANETARY ATMOSPHERES
ORGANIZATION: NASA HEADQUARTERS
MONITOR: FELLOWS, R. F. TEL. 202-962-1861

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE SUPPORT FOR ANALYSIS OF RESULTS OF FLIGHT EXPERIMENTS BEYOND THE COVERAGE PROVIDED BY THE FLIGHT PROJECT. THIS RTOP IS CONCERNED WITH RESEARCH RELATING TO THE EARTH'S UPPER ATMOSPHERE, THE ATMOSPHERES OF THE OTHER PLANETS, COMETS, AND THE LUNAR ATMOSPHERE.

RTOP NO. 384-50-51 TITLE: MARS SURFACE MORPHOLOGY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-1111
TECHNICAL SUMMARY

BRIEF TECHNICAL SUMMARY/ABSTRACT (WHAT IS BEING DONE, HOW, WHY)
THE PRESENT MARTIAN SURFACE HAS EVOLVED FROM ENDOGENETIC AND EXOGENETIC PROCESSES. MEANINGFUL INTERPRETATIONS OF SURFACE STRUCTURES AND GEOMORPHIC REGIONS THROUGH ANALYSIS OF MARTIAN PHOTOGRAPHS AND TERRESTRIAL ANALOGS WILL LEAD TO FORMULATION OF A SPECIFIC MODEL OF THE MARTIAN SURFACE. THESE INTERPRETATIONS CAN BE UTILIZED IN SITE SELECTION FOR FUTURE MARTIAN ORBITING AND LANDER MISSIONS.

RTOP NO. 384-50-71 TITLE: PLANETOLOGY DATA ANALYSIS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

VARIOUS TASKS PROPOSE TO EXPLOIT THE MARINER 6 AND 7 SPACECRAFT DATA FOR SCIENTIFIC KNOWLEDGE, AND TO IMPROVE THE SCIENCE RETURN OF SUBSEQUENT MISSIONS. A PHOTOGEOLOGICAL INTERPRETATION OF TELEVISION IMAGES FOR THE PURPOSE OF DELINEATING THE ABUNDANCE, FORM, ARRANGEMENT AND SIZES OF MORPHOLOGIC FEATURES ON THE MARTIAN SURFACE WILL BE MADE. PRIMARY OBJECTIVE IS TO DETERMINE THE NATURE AND EXTENT OF SURFACE PROCESSES AND INTERNAL TECTONIC PROCESSES THAT FORM AND MODIFY SURFACE FEATURES. RESULTS WILL BE USED TO MAKE COMPARISONS WITH LUNAR AND EARTH PROCESSES AND TO CONSTRUCT A GEOLOGIC HISTORY FOR MARS. RECOMMENDATIONS WILL BE MADE FOR TELEVISION COVERAGE OF KEY AREAS ON MARS BY FUTURE ORBITER SPACECRAFT EXPERIMENTS. ADDITIONALLY THE PHOTOMETRIC DESCRIPTION OF MARS WILL BE IMPROVED AND A PICTORIAL ATLAS PRODUCED. THE IMAGE PROCESSING LABORATORY (IPL) WILL BE PROVIDED TO ASSIST MARINER '69 TV EXPERIMENTERS IN POST MISSION DATA ANALYSIS. THE TRACKING DATA WILL BE EXAMINED TO IMPROVE THE EPHEMERIDES OF EARTH AND MARS.

RTOP NO. 384-50-80 TITLE: DATA ANALYSIS - PLANETOLOGY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: DWORNIK, S. E. TEL. 202-962-1151
TECHNICAL SUMMARY

OBJECTIVE: TO ANALYZE FLIGHT MISSION DATA FOR GEOPHYSICAL, GEOCHEMICAL, AND GEOLOGICAL PURPOSES, FOR SURFACE, SUBSURFACE AND ATMOSPHERE-LITHOSPHERE PHENOMENON. PRIMARY EMPHASIS WILL BE PHOTOGEOLOGICAL INTERPRETATION OF PHOTOGRAPHS OBTAINED FROM MARINER 6 AND 7. THE PHOTOGRAPHS WILL BE CATALOGED AND CLASSIFIED ACCORDING TO TOPOGRAPHIC AND GEOMORPHIC FEATURES, AND WILL BE ASSEMBLED INTO A PHOTO-INTERPRETATION KEY SUITABLE AS A REFERENCE DOCUMENT. THE ABUNDANCE, SHAPE AND ARRANGEMENT OF GEOMORPHIC FEATURES WILL BE STUDIED AND MAPPED. A TERRAIN ANALYSIS WILL BE CONDUCTED IN ORDER TO QUANTITATIVELY CLASSIFY LAND FORMS. THE NATURE AND EXTENT OF SURFACE EROSIONAL AND DEPOSITIONAL PROCESSES, INTERNAL TECTONIC PROCESSES, AND EXTERNAL VOLCANIC FEATURES WILL BE STUDIED. TOPOGRAPHIC FEATURES

WILL BE ANALYZED FOR GEOCHEMICAL IMPLICATIONS. THIS WORK WILL PROVIDE A BASIS FOR A SYSTEMATIC GEOLOGICAL MAPPING PROGRAM OF MARS. GEOLOGICAL MAPPING STANDARDS AND CRITERIA WILL BE ESTABLISHED. ANALYSIS OF THE PHOTOGRAPHS WILL BE PERFORMED FOR SELECTION OF CANDIDATE MARS LANDER MISSIONS SITES.

RTOP NO. 704-13-01 TITLE: SERT II
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: RULIS, R. J. TEL. 206-433-4000
TECHNICAL SUMMARY

THE OBJECTIVES OF THE SERT II PROGRAM ARE TO DEMONSTRATE THE ENDURANCE CAPABILITY, RELIABILITY, AND COMPATIBILITY OF AN INTEGRATED ION THRUSTOR SYSTEM CAPABLE OF PERFORMING SPACE MISSIONS. AN ELECTRIC PROPULSION SYSTEM CONSISTING OF A THRUSTOR, POWER SUPPLY, POWER CONDITIONING AND RELATED EXPERIMENTS WILL BE SUBJECTED TO A FLIGHT PROGRAM OF SIX MONTHS DURATION. THE SERT II SPACECRAFT WAS SUCCESSFULLY LAUNCHED FEBRUARY 3, 1970

RTOP NO. 708-40-01 TITLE: SPACE STATION BIOTECHNOLOGY FLIGHT
EXPERIMENT DEFINITION

ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-1111
TECHNICAL SUMMARY

A NUMBER OF BIOMEDICAL FLIGHT EXPERIMENTS SUITABLE FOR USE IN THE 1975 SPACE STATION ARE BEING PREPARED. THESE FLIGHT EXPERIMENTS WILL PROVIDE KNOWLEDGE ABOUT THE EFFECTS OF WEIGHTLESSNESS ON THE BEHAVIORAL AND BIOMEDICAL PERFORMANCE OF ANIMALS AND MAN, ABOUT ADAPTATION TO A CHANGED ENVIRONMENT AND THE MECHANISMS UNDERLYING SUCH ADAPTATIONS, AND ON WHICH TO PREDICT MAN'S PERFORMANCE DURING LONG TIME DURATION SPACE FLIGHTS. EXPERIMENTS BEING PREPARED THAT INVOLVE MAN AS THE SUBJECT ARE: (1) LOCOMOTION; (2) ARDIOVASCULAR FUNCTION; (3) MICROBIOLOGICAL SYSTEMS; AND (4) CARDIOPULMONARY FUNCTION. EXPERIMENTS UNDER PREPARATION REQUIRING THE USE OF ANIMALS ARE: (1) BASAL METABOLISM OF MAMMALS UNDER VARYING GRAVITATIONAL FIELDS; (2) REGENERATION OF TISSUE (E.G., LIVER) UNDER VARYING GRAVITY FIELDS; (3) HEALING AND RECOVERY FROM WOUNDS AND FRACTURES IN WEIGHTLESSNESS; (4) CALCIUM METABOLISM; AND (5) ADAPTATION AND FUNCTION OF THE CARDIOVASCULAR SYSTEM. THESE BIOMEDICAL FLIGHT EXPERIMENTS WILL PROVIDE NECESSARY KNOWLEDGE ON THE EXTENT TO WHICH ADAPTATION TO A CHANGED ENVIRONMENT CAN OCCUR, UNDERSTANDING OF THE MECHANISMS BY WHICH SUCH ADAPTATION OCCURS, AND WILL PROVIDE A BASIS ON WHICH TO PREDICT THE EFFECT OF A FUTURE STRESS.

RTOP NO. 708-40-01 TITLE: SPACE STATION BIOTECHNOLOGY FLIGHT
EXPERIMENT DEFINITION

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3666

TECHNICAL SUMMARY

THE SPACE STATION/BASE WILL REQUIRE AHABITABLE AND SAFE ENVIRONMENT FOR THE CREW OVER LONG PERIODS OF TIME. IN ADDITION, MAN'S CAPABILITY TO WORK IN THIS ENVIRONMENT FOR LONG PERIODS MUST BE VERIFIED. FIVE FLIGHT EXPERIMENTS WILL BE DEVELOPED TO SUPPORT THE SPACE STATION/BASE MISSION IN THE TECHNOLOGICAL AREAS OF LIFE SUPPORT AND SUPPORTING EQUIPMENT. EXPERIMENTS ARE: 1.) ORBITAL PRIMATE EXPERIMENT: PRIMATE WILL BE OBSERVED OVER AN EXTENDED DURATION IN THE SPACE ENVIRONMENT TO PROVIDE GUIDANCE IN THE RESEARCH PROGRAM TO VALIDATE LONG DURATION MANNED CAPABILITY. 2.) BIOTECHNOLOGY LABORATORY: A BIOTECHNOLOGY LABORATORY WILL BE DEVELOPED FOR INTEGRATION WITH SKYLAB II. EXPERIMENTS RELATED TO BIOMEDICINE AND MAN-SYSTEM INTEGRATION, ETC., WILL BE CONDUCTED. 3.) LIFE SUPPORT SYSTEMS: TWO LIFE SUPPORT SYSTEMS EXPERIMENTS WILL BE DEVELOPED. ONE IS TO VERIFY OPERATION OF REGENERATIVE SYSTEMS CONCEPTS ON SKYLAB II. THE SECOND IS AN INTEGRATED EXPERIMENT PROGRAM TO VERIFY ANALYTICAL DESIGN MODELS. 4.) ORBITING CENTRIFUGE: AN ORBITING CENTRIFUGE AND EXPERIMENT PROGRAM WILL BE DEVELOPED FOR CONDUCTING MANNED EXPERIMENTS IN SPACE. THIS FACILITY WILL PROVIDE INFORMATION ON MAN'S PSYCHOPHYSIOLOGICAL RESPONSE TO VARIOUS GRAVITY ENVIRONMENTS.

RTOP NO. 709-13-01 TITLE: RADIATION METEOROID SATELLITE

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: MCALLUM TEL. 713-483-7661

TECHNICAL SUMMARY

A SCIENTIFIC INSTRUMENT PACKAGE WILL BE LAUNCHED SIMULTANEOUSLY WITH THE ORBITING FROG OTOLITH EXPERIMENT ON A SCOUT VEHICLE. THE INSTRUMENT PACKAGE CONSISTS OF TWO EXPERIMENTS: (1) A NUCLEAR RADIATION EXPERIMENT COMPOSED OF A SOLID-STATE RADIATION SPECTROMETER, A REAL-TIME, PULSE-HEIGHT, SPECTRUM-TO-DOSE CONVERTER AND THREE IONIZATION CHAMBERS AND, (2) A METEOROID EXPERIMENT CAPABLE OF MEASURING BOTH PARTICLE FLUX AND VELOCITY UTILIZING THIN-FILM, CAPACITOR SENSORS. THE EXPERIMENTS WILL PROVIDE FLIGHT VERIFICATION OF A NEWLY DEVELOPED SPECTRUM-TO-DOSE CONVERSION SYSTEM FOR IMPROVED RADIATION DOSIMETRY ON MANNED SPACE VEHICLES AND WILL FLIGHT TEST A THIN-FILM METEOROID DETECTOR FOR USE ON LARGE AREA INSTRUMENTS.

RTOP NO. 709-16-02 TITLE: LANGLEY RESEARCH CENTER SPACE TECHNOLOGY
SMALL FLIGHTS PROJECT

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: SANDAHL, C. A. TEL. 703-827-3704

TECHNICAL SUMMARY

SMALL FLIGHT PROJECTS ARE CONDUCTED AS AN INTEGRAL PART OF SPACE TECHNOLOGY RESEARCH WHERE REQUIRED TO SUPPLEMENT, PROVIDE AN INPUT TO OR FOCAL POINT FOR, GROUND TEST AND ANALYSIS OR WHERE DATA ARE REQUIRED THAT CAN BE OBTAINED ONLY IN FLIGHT. SPECIFIC EXPERIMENTS ARE CONDUCTED IN ACCORDANCE WITH CENTER PROPOSALS APPROVED BY HEADQUARTERS. CURRENT ACTIVITIES ARE CONCENTRATED IN AERODYNAMIC DECELERATION SYSTEMS APPLICABLE TO THE VIKING PROJECT AND TO FUTURE SPACE MISSIONS.

RTOP NO. 711-02-11 TITLE: PLANETARY ATMOSPHERE EXPERIMENTS TEST

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THE PLANETARY ATMOSPHERE EXPERIMENTS TEST (PAET) IS TO DEMONSTRATE IN THE EARTH'S ATMOSPHERE THE ABILITY OF SELECTED EXPERIMENTS TO DETERMINE THE STRUCTURE AND COMPOSITION OF AN UNKNOWN PLANETARY ATMOSPHERE FROM A PROBE VEHICLE ENTERING THE ATMOSPHERE AT HIGH SPEEDS. RESULTS FROM THIS TEST WILL PROVIDE FLIGHT EXPERIENCE FOR THE EVALUATION OF EXPERIMENTS APPLICABLE TO ENTRY MISSIONS TO MARS AND VENUS. THREE EXPERIMENTS WILL BE FLOWN; AN ATMOSPHERE STRUCTURE EXPERIMENT, A SHOCK-LAYER RADIOMETER COMPOSITION EXPERIMENT, AND A MASSSPECTROMETER COMPOSITION EXPERIMENT. AN ENTRY VEHICLE DESIGNED TO ACCOMMODATE THESE EXPERIMENTS WILL BE BUILT AT AMES RESEARCH CENTER. THE ENTRY VEHICLE WILL BE FLOWN FROM WALLOPS ISLAND ON A FOUR-STAGE SCOUT LAUNCH VEHICLE. ENTRY WILL OCCUR NEAR BERMUDA.

RTOP NO. 713-01-01 TITLE: METEOROID TECHNOLOGY SATELLITE

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: SANDAHL, C. A. TEL. 703-827-3704

TECHNICAL SUMMARY

THE METEOROID TECHNOLOGY SATELLITE IS A SCOUT LAUNCHED NEAR-EARTH EXPERIMENT TO OBTAIN BASELINE DATA ON THE EFFECTIVENESS OF BUMPERS OR MULTI-WALL STRUCTURES AND THE VELOCITY DISTRIBUTION OF METEORIDS. MEASUREMENT WILL ALSO BE MADE OF THE FLUX OF VERY SMALL MASS METEORIDS. THE VELOCITY MEASUREMENT WILL BE A JOINT LARC/MSR EXPERIMENT.

RTOP NO. 718-21-01 TITLE: NUCLEAR ROCKET MATERIALS-RADIATION EFFECTS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: BARKLEY, H. B. TEL. 216-433-4000
TECHNICAL SUMMARY

PROSPECTIVE NERVA MATERIALS NEED RADIATION EFFECTS DATA. THESE NERVA MATERIALS WILL BE IRRADIATED FOR SNPO-C AT THE PLUM BROOK TEST REACTOR. POST-IRRADIATION TESTING WILL BE CONDUCTED AT SITES SELECTED BY SNPO-C, INCLUDING PLUM BROOK. THE IRRADIATIONS WILL BE DONE IN ENVIRONMENTS THAT SIMULATE THE NERVA REACTOR CONDITIONS. THE TEST CONDITIONS INCLUDE NEUTRON AND GAMMA RADIATION; TEMPERATURES FROM 50 DEGREES R TO AMBIENT TO 2000 DEGREES F; AND LIQUID HYDROGEN, GASEOUS HYDROGEN AND HELIUM, AND WATER ENVIRONMENTS. THE TEST RESULTS WILL AID IN SELECTION OF MATERIALS FOR THE UPRATED NERVA.

RTOP NO. 720-01-10 TITLE: AERONAUTICS OF ADVANCED AIRCRAFT
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

TO DEVELOP THE AERODYNAMIC-STRUCTURES TECHNOLOGY WHICH WOULD SERVE AS A BASIS FOR AN IMPROVED SUPERSONIC TRANSPORT AIRCRAFT IN TERMS OF MAXIMUM AERODYNAMIC PERFORMANCE AT BOTH SUPERSONIC AND SUBSONIC SPEEDS AND TO PROVIDE SUFFICIENT CONTROL POWER FOR ALL PHASES OF FLIGHT. THE RESULTS COULD BE APPLIED TO PRODUCTION SUPERSONIC TRANSPORT CONFIGURATIONS. BOTH ANALYTICAL AND EXPERIMENTAL RESEARCH ON AEROELASTIC CONFIGURATIONS WILL BE CONTINUED AND SUPERSONIC AERODYNAMIC COMPUTER PROGRAMS WILL BE EXTENDED TO COVER ACCURATE WING LOAD CONDITIONS DURING MANEUVER AND UPSET CONDITIONS OF FLIGHT. OFF DESIGN CONDITIONS AT SUBSONIC AND HIGH TRANSONIC SPEEDS WILL BE DETERMINED WITH WIND-TUNNEL PRESSURE INSTRUMENTED MODELS.

RTOP NO. 720-01-10 TITLE: AERODYNAMICS OF ADVANCED SUPERSONIC
TRANSPORTS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-1111
TECHNICAL SUMMARY

THE CURRENT SUPERSONIC TRANSPORT PROGRAM HAS REACHED A STAGE WHERE RESEARCH EFFORT ON GROWTH VERSIONS SHOULD BE CONSIDERED. DESIGN OF THE CURRENT SST HAS REVEALED AREAS IN WHICH FURTHER RESEARCH WOULD BE EXPECTED TO PRODUCE IMPROVEMENTS IN OPERATING EFFICIENCY, PERFORMANCE, AND SAFETY. RESEARCH WOULD BE CARRIED OUT THROUGH INITIAL ANALYTICAL STUDIES, FOLLOWED BY SUBSTANTIATING DATA OBTAINED IN GROUND BASED FACILITIES SUCH AS WIND TUNNELS AND FLIGHT SIMULATORS. ONE SPECIFIC ASPECT OF THIS PROGRAM INVOLVES A COMPARISON OF XB-70 FLIGHT RESULTS WITH COMPUTED ESTIMATES BASED ON WIND TUNNEL TESTS AND CALCULATED AEROELASTIC EFFECTS.

RTOP NO. 720-01-11 TITLE: ADVANCED MILITARY AIRCRAFT
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-1111
TECHNICAL SUMMARY

AS A CONSEQUENCE OF ITS OBLIGATION TO THE NATIONAL INTEREST AND ITS AERONAUTICAL RESEARCH COMPETENCE, THE NASA HAS MAINTAINED A CONTINUOUS COOPERATIVE EFFORT WITH THE DEPARTMENT OF DEFENSE. ONE PHASE OF THIS EFFORT IS CONCERNED WITH PROVIDING AERODYNAMIC TECHNOLOGY, IN TERMS OF DATA AND CONSULTATION, NEEDED FOR THE CONCEPTION AND DESIGN OF ADVANCED MILITARY AIRCRAFT. THIS SUPPORT ENCOMPASSES A WIDE RANGE OF ACTIVITIES, INCLUDING ANALYTICAL REVIEW, TESTING, AND CONSULTATION WITH RESPECT TO PROJECTED MILITARY AIRCRAFT, AND ALSO THEORETICAL AND EXPERIMENTAL STUDIES OF ADVANCED THEORIES OR IDEAS WHICH USUALLY PRECEDE ADVANCED MILITARY CONCEPTS. REFER TO RTOP 126-63-11 FOR DESCRIPTION OF SUPPORTING RESEARCH TO BE PERFORMED ON ADVANCED FIGHTER CONCEPTS, AS A RESULT OF SPECIFIC REQUESTS FROM DOD.

RTOP NO. 720-01-11 TITLE: ADVANCED MILITARY AIRCRAFT
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE IS TO APPLY THE ADVANCES FROM THE FUNDAMENTAL DISCIPLINARY RESEARCH EFFORTS TO PRACTICAL AERODYNAMIC, PROPULSION, AND STRUCTURAL DESIGN TECHNIQUES TO PROVIDE EFFICIENT SUPERSONIC MILITARY AIRCRAFT AND MISSILES. CURRENT EMPHASIS IS FOCUSED ON THE USN F-14, USAF F-15, AND USAF B-1A AND A HOST OF MISSILES. FUTURE EMPHASIS WILL BE ON USAF AMI AND USN ADLI, LIGHTWEIGHT MANEUVERING FIGHTERS, AND DOGFIGHT MISSILES. THE PERFORMANCE AND STABILITY/CONTROL ARE BEING STUDIED BY USE OF AUTOMATED ANALYTIC TECHNIQUES AND WIND-TUNNEL EXPERIMENTS. INLET RESEARCH IS DIRECTED TOWARDS AN UNDERSTANDING OF THE FLOW FIELDS GENERATED BY THE FUSELAGE AT THE INLETS OF TYPICAL MANEUVERING AIRCRAFT. ANOTHER AREA OF CONCERN IS THE PREDICTION OF THE INSTALLED DRAG OF THE INLET SYSTEM, INCLUDING INTERFERENCE EFFECTS. EXPERIMENTAL RESEARCH ON THE JET EXHAUST NOZZLE SYSTEM IS DIRECTED TOWARD THE ATTAINMENT OF IMPROVED PERFORMANCE AND AN UNDERSTANDING OF THE NOZZLE-AIRFRAME INTERFERENCE CHARACTERISTICS. A CAPABILITY TO ESTIMATE THE AIRCRAFT WEIGHT AND BALANCE CHARACTERISTICS IS BEING DEVELOPED. INITIALLY THE UNDERSTANDING AND USE OF PARAMETRIC STATISTICAL METHODS ARE BEING UNDERTAKEN. THE MORE ADVANCED TECHNIQUES WILL BE APPROACHED AS SKILL IS ACQUIRED.

RTOP NO. 720-02-10 TITLE: AEROELASTICITY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

A BETTER UNDERSTANDING OF THE AEROELASTIC CHARACTERISTICS OF SUPERSONIC CONFIGURATIONS IS REQUIRED IN ORDER TO PROVIDE SAFE, EFFICIENT SUPERSONIC AIRCRAFT. SUPERSONIC AIRCRAFT TEND TO BE LONG

AND SLENDER, LEADING TO RELATIVELY FLEXIBLE DESIGNS. FLUTTER, GUST RESPONSE, AND ELASTIC EFFECTS ON STABILITY AND CONTROL CAN HAVE A SIGNIFICANT INFLUENCE ON THE DESIGN OF SUCH AIRCRAFT. THIS RESEARCH IS INTENDED TO PROVIDE INFORMATION ON THE AEROELASTIC CHARACTERISTICS IN CONFIGURATION STUDIES FOR SUCH AIRCRAFT AS THE SUPERSONIC TRANSPORT AND B-1.

RTOP NO. 720-02-11 TITLE: MATERIALS AND STRUCTURES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVES ARE TO: INVESTIGATE ADVANCED RESINS AND ADHESIVES THAT MAY BE SUITABLE FOR USE IN SUPERSONIC AIRCRAFT STRUCTURAL APPLICATIONS. THE WORK INCLUDES DEVELOPMENT OF NEW OR ADVANCED POLYIMIDES AND PYRRONES AND EVALUATION OF THESE MATERIALS UNDER APPROPRIATE ENVIRONMENTAL TESTS. INCLUDED ALSO ARE DEVELOPMENT OF FABRICATION METHODS FOR MOLDING COMPOSITES AND FOR BONDING COMPOSITES ONTO METALS. PRIMARY INTEREST WILL BE DIRECTED AT BONDING BORON OR GRAPHITE COMPOSITES ONTO TITANIUM ALLOYS. TO INVESTIGATE THE EFFECTS OF SUPERSONIC FLIGHT ENVIRONMENT ON THE SALT STRESS CORROSION, EROSION, AND OTHER THERMAL DEGRADATION EFFECTS ON SUPERSONIC AIRCRAFT STRUCTURAL MATERIALS. OF PRIMARY CONCERN ARE AIR VELOCITIES TO MACH 3, TEMPERATURES TO 600 DEGREES F, AND ALTITUDES TO 70,000 FEET. THE MATERIALS TESTS WILL FOCUS INITIALLY ON TITANIUM ALLOYS AND WILL BE CONDUCTED IN THE RECENTLY INSTALLED MATERIALS TESTS SYSTEM SUITABLE FOR THIS TYPE OF RESEARCH. CORRELATION OF THE RESULTS WILL BE MADE WITH DATA OBTAINED IN THE LABORATORY UNDER STATIC ENVIRONMENTAL CONDITIONS. THIS WORK WILL HELP TO PROVIDE CONFIDENCE IN THE UTILIZATION OF NEW OR ADVANCED MATERIALS IN AIRCRAFT STRUCTURES THROUGH DEFINITION OF NEW RESINS OR ADHESIVES THAT WILL BE PARTICULARLY USEFUL FOR APPLICATIONS OF ADVANCED FILAMENTARY COMPOSITES, AND WILL ALSO PROVIDE MEANINGFUL DATA ON THE SALT STRESS CORROSION PROBLEM FOR SUPERSONIC AIRCRAFT FABRICATED FROM TITANIUM ALLOYS.

RTOP NO. 720-02-12 TITLE: POLYMERS FOR FUEL TANK SEALANTS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE THE DEVELOPMENT OF THERMALLY STABLE FUEL RESISTANT BASE MATERIALS, THE CONVERSION OF THESE BASE MATERIALS INTO PRACTICAL FUEL TANK SEALANTS, AND THE DEVELOPMENT OF A TEST METHODOLOGY AND PROCEDURE THAT CAN BE APPLIED IN A SHORT TIME TO THESE AND OTHER SEALANTS. THIS TASK UNDER CONTRACT NAS8-21399, TO MONSANTO RESEARCH LABORATORIES, DAYTON, OHIO HAS AS ITS OBJECTIVE THE PROCESSING, APPLICATION, AND EVALUATION OF SEALANTS FOR FUEL TANKS IN ADVANCED AEROSPACE STRUCTURES. THE SECOND TASK IS SUBDIVIDED INTO TWO SEPARATE EFFORTS BOTH OF WHICH HAVE THE SAME COMMON GOAL - THE PREDICTION OF SERVICE LIFE OF POLYMERIC SEALANT COMPOSITIONS FOR FUEL TANKS IN AEROSPACE STRUCTURES FROM MEASUREMENTS OF VISCOELASTIC

PROPERTIES. THIS TASK IS BEING PURSUED BY THE NATIONAL BUREAU OF STANDARDS, WASHINGTON, D. C., UNDER GWO H-68638A, AND BY THE JET PROPULSION LABORATORY, PASADENA, CALIFORNIA, UNDER AN AS YET UNASSIGNED GWO (DCN 1-0-50-09656) .

RTOP NO. 720-02-13 TITLE: STATIC AND ELASTIC CHARACTERISTICS OF AIRCRAFT STRUCTURES

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: JENKINS, J. M. TEL. 805-258-3311

TECHNICAL SUMMARY

STRUCTURES AND MATERIALS CURRENTLY USED AND CONTEMPLATED FOR THE FUTURE HAVE INDUCED SERIOUS PROBLEMS IN THE AREA OF SUPERSONIC FLIGHT. STRAIN-GAGE MEASUREMENTS CONTINUE TO PROVIDE THE MOST SIGNIFICANT INFORMATION RELATING THE PERFORMANCE OF THE STRUCTURE AND ITS FLIGHT ENVIRONMENT. RESEARCH WILL BE DIRECTED TOWARD CONTINUING TO SOLVE SUCH PROBLEMS AS THE DEVELOPMENT OF HIGH-TEMPERATURE STRAIN SENSORS, THE EFFECT OF STRAIN-GAGE INSTALLATION ON THE FATIGUE PROPERTIES OF HIGH-PERFORMANCE MATERIALS, AND THE PREDICTION TECHNIQUES OF STRESSES AND DEFLECTIONS OF COMPLEX STRUCTURES.

RTOP NO. 720-02-15 TITLE: LOADS ALLEVIATION AND MODE SUPPRESSION PROGRAM

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: KORDES, E. E. TEL. 805-258-3311

TECHNICAL SUMMARY

THIS STUDY IS DIRECTED TOWARD PRACTICAL SOLUTIONS TO IMPROVE FATIGUE AND/OR SERVICE LIFE, REDUCE FLIGHT LOADS, AND IMPROVE RIDE QUALITIES OF LARGE FLEXIBLE VEHICLES SUCH AS THE SST AND B-1. THE STUDY IS BASED ON THE USE OF AUTOMATIC CLOSED-LOOP CONTROL SYSTEM TECHNIQUES TO ACTIVELY REDUCE THE DYNAMIC RESPONSE OF THE TOTAL AIRFRAME DURING DYNAMIC DISTURBANCES SUCH AS BUFFET AND TURBULENCE. THE FY '71 EFFORT WAS CONDUCTED UNDER CONTRACT TO LOCKHEED AS A FEASIBILITY STUDY FOR FLIGHT TESTING A SYSTEM ON THE YF-12 AIRPLANE.

RTOP NO. 720-03-10 TITLE: INLETS, INLET CONTROLS, AND INLET-ENGINE DYNAMICS

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: BELLMAN, D. R. TEL. 805-258-3311

TECHNICAL SUMMARY

AIR INTAKE PROBLEMS INCREASE GREATLY AS THE SPEED OF AIRCRAFT ADVANCE INTO THE SUPERSONIC REGION. MUCH OF THE RESEARCH IN THIS AREA MUST BE DONE IN FULL-SCALE FLIGHT BECAUSE OF UNKNOWN SCALING EFFECTS AND A LACK OF LARGE SUPERSONIC WIND TUNNELS. STATIC AND DYNAMIC CONDITIONS IN AND AROUND THE INLET AND ENGINE ARE BEING MEASURED IN FULL-SCALE FLIGHT FOR A SERIES OF SUPERSONIC AIRCRAFT. THE EFFECT OF FLOW DISTORTION AND TURBULENCE LEVELS WITHIN THE INLET ON THE JET ENGINE AND THE OCCURRENCE OF COMPRESSOR STALLS IS BEING STUDIED. INITIAL WORK IS BEING DONE ON AN F-111A AIRPLANE AND A

PROGRAM ON THE YF-12 AIRPLANE IS IN THE PLANNING STAGE. LATER, IT IS HOPED TO CONTINUE THE WORK ON SUCH AIRCRAFT AS THE F-14, THE F-15, AND AMSA.

RTOP NO. 720-03-10 TITLE: INLETS, INLET CONTROLS, AND INLET ENGINE DYNAMICS

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: BEHEIM, M. TEL. 216-433-4000

TECHNICAL SUMMARY

THE OBJECTIVE IS TO CONTINUE TO DEVELOP THE TECHNOLOGY REQUIRED FOR THE DESIGN OF INLETS AND CONTROL SYSTEMS OF FUTURE SUPERSONIC AIRCRAFT. PARTICULAR EMPHASIS WILL BE PLACED ON THE STABILITY PROBLEMS OF HIGH-PERFORMANCE INLETS AND CONTROLS AT THEIR DESIGN SPEED, ON THE PERFORMANCE AND VARIABLE-GEOMETRY PROBLEMS THAT ARE ENCOUNTERED DURING OFF-DESIGN OPERATION, AND ON THE MUTUAL INTERACTION PROBLEMS THAT RESULT WHEN INTEGRATING THESE COMPONENTS INTO A COMPLETE AIRFRAME AND PROPULSION SYSTEM. THIS EFFORT IS CLOSELY RELATED TO THE TURBOJET AND TURBOFAN ENGINE SYSTEM RESEARCH DESCRIBED IN RTOP 720-03-15. RESULTS WOULD BE APPLICABLE TO SUPERSONIC DASH MILITARY AIRCRAFT AND TO SUPERSONIC CRUISE COMMERCIAL AIRCRAFT.

RTOP NO. 720-03-10 TITLE: INLETS, INLET CONTROLS, AND INLET-ENGINE DYNAMICS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVES ARE TO DEVELOP AN UNDERSTANDING OF THE INLET REQUIREMENTS FOR FUTURE AIRCRAFT, TO DETERMINE THE TYPES OF DESIGNS WHICH SATISFY THESE REQUIREMENTS, TO PROVIDE THE TECHNOLOGY REQUIRED TO ASSURE SUCCESSFUL OPERATION OF THESE INLETS, AND TO DEVELOP GENERAL METHODS FOR PREDICTING THE DRAG CHARACTERISTICS OF INLETS. A RELATED OBJECTIVE IS TO DEVELOP METHODS FOR PREDICTING THE PERFORMANCE OF SUPERSONIC COMPRESSORS SO THAT RELIABLE ANALYSES MAY BE CONDUCTED TO ESTABLISH THE BENEFITS TO FUTURE AIRCRAFT WHICH MAY RESULT FROM THE USE OF PROPULSION SYSTEMS DESIGNED AROUND SUPERSONIC INLET-SUPERSONIC COMPRESSOR CONCEPTS. THE RESEARCH IS APPLICABLE TO MILITARY AND COMMERCIAL AIRCRAFT WHICH OPERATE AT SUBSONIC AND SUPERSONIC SPEEDS. BOTH ANALYTICAL AND EXPERIMENTAL APPROACHES WILL BE USED TO ACHIEVE THE OBJECTIVES.

RTOP NO. 720-03-10 TITLE: SUPERSONIC INLETS, INLET CONTROLS, INLET-ENGINE DYNAMICS, AND RELATED PROBLEMS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, L. TEL. 415-961-1111

TECHNICAL SUMMARY

THE DESIGN AND OPERATION OF ENGINE AIR INLETS FOR SUPERSONIC AIRPLANES INVOLVES MANY PROBLEMS WHICH VARY IN NATURE BUT ARE, IN

GENERAL, ASSOCIATED WITH ATTEMPTS TO OBTAIN A RELATIVELY UNIFORM SUPPLY OF AIR AT THE ENGINE FACE, WITH MINIMUM ENERGY LOSS TO THAT AIR, AT OFF-DESIGN AS WELL AS CRUISE SPEEDS, WITH MINIMUM MECHANICAL COMPLICATION AND WEIGHT PENALTY, AND MINIMUM DISTURBANCE TO THE EXTERNAL AERODYNAMICS OF THE AIRPLANE. CONSEQUENTLY, INLET RESEARCH RANGES FROM BASIC AERODYNAMIC STUDIES OF BOUNDARY LAYER GROWTH AND SHOCK WAVE INTERACTION TO VARIOUS MECHANICAL-ELECTRICAL-PNEUMATIC DEVICES FOR CONTROL OF THE NORMAL SHOCK POSITION. ANALYTICAL STUDIES WITH ELECTRONIC COMPUTERS, AND EXPERIMENTAL INVESTIGATIONS IN GROUND BASED FACILITIES ARE USED TO ATTACK THESE PROBLEMS. THE RESEARCH OF THIS RESUME WILL INCLUDE A COOPERATIVE AMES/BOEING/FAA EFFORT TO PROVIDE AN IMPROVED DESIGN FOR THE PRODUCTION SST INLET AND DIFFUSER.

PRESENT PLANS CALL FOR THE DESIGN, FABRICATION, AND TESTING OF A LARGE-SCALE INLET MODEL CAPABLE OF BEING MODIFIED TO REPRESENT (IN SEPARATE TESTS) THE BOEING PROTOTYPE SST INLET AND AN AMES-DESIGNED INLET FOR THE PRODUCTION AIRPLANE.

RTOP NO. 720-03-11 TITLE: JET EXHAUST SYSTEMS

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: BEHEIM, M. TEL. 216-433-4000

TECHNICAL SUMMARY

THE OBJECTIVE IS TO CONTINUE TO DEVELOP THE TECHNOLOGY REQUIRED FOR THE DESIGN OF NOZZLES OF FUTURE SUPERSONIC AIRCRAFT. PARTICULAR EMPHASIS WILL BE PLACED ON THE PERFORMION OVER A BROAD RANGE OF FLIGHT SPEEDS. IN ADDITION STUDIES WILL BE MADE OF THE MUTUAL INTERACTION PROBLEMS THAT OCCUR WHEN INTEGRATING THE NOZZLE INTO A COMPLETE AIRFRAME AND PROPULSION SYSTEM. THIS EFFORT IS CLOSELY RELATED TO THE TURBOJET AND INLET SYSTEM RESEARCH DESCRIBED IN RTOP'S 720-03-10 AND 720-03-15, AND SEVERAL OF THE TEST MODEL COMPONENTS WILL SO BE USED IN THE INLET PROGRAM. RESULTS WOULD BE APPLICABLE TO SUPERSONIC DASH MILITARY AIRCRAFT AND TO SUPERSONIC CRUISE COMMERCIAL AIRCRAFT.

RTOP NO. 720-03-11 TITLE: JET EXHAUST SYSTEMS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

A PRIME GOAL OF JET EXIT RESEARCH IS TO ACHIEVE EXHAUST NOZZLE DESIGNS CAPABLE OF NEAR IDEAL CONVERSION OF THE PRESSURE AND THERMAL ENERGY OF THE ENGINE INTERNAL FLOW INTO THRUST OF THE EXHAUST JET; AND, TO DEVISE AND INVESTIGATE EXHAUST NOZZLE MECHANISMS WHICH PERMIT VARIATION OF THROAT SIZE AND NOZZLE EXPANSION RATIO TO MAINTAIN THIS NEAR IDEAL PERFORMANCE OVER ANY REQUIRED RANGE OF VEHICLE AIRSPEED AND NOZZLE PRESSURE RATIO. AN EQUALLY IMPORTANT GOAL IS REALIZATION OF SYSTEMATIC DESIGN PROCEDURES FOR INCORPORATION OF SINGLE OR MULTIPLE EXHAUST NOZZLES INTO AN AIRFRAME TO YIELD A CONFIGURATION NOT PENALIZED BY LOSS OF THRUST OR INCREASE IN DRAG RELATED TO THE EXHAUST NOZZLE INSTALLATION. A FURTHER GOAL IS CONTINUED STUDY OF BOUNDARY LAYER AND JET MIXING, AND OF JET EFFECTS ON BASE AND BOATTAIL DRAG, AND TO REDUCE TO SCIENCE THE KNOWLEDGE OF THESE MUTUAL

INTERFERENCES BETWEEN EXHAUST JET PLUME, AIRFRAME, AND EXTERNAL AIRSTREAM, WITH A VIEW TO EXPLOIT THESE PHENOMENA FOR ACHIEVEMENT OF IMPROVED VEHICLE PERFORMANCE. THE TERM EXHAUST NOZZLE HERE IS MEANT TO INCLUDE JET NOISE SUPPRESSORS AND THRUST REVERSERS.

RTOP NO. 720-03-12 TITLE: COMPRESSORS AND FANS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: HARTMANN, M. J. TEL. 216-433-6650
TECHNICAL SUMMARY

APPROACHES TO REDUCE COMPRESSOR AND FAN COMPONENT WEIGHT AND IMPROVE PERFORMANCE WILL BE INVESTIGATED. THESE COMPONENTS MUST PROVIDE EFFICIENT COMPRESSION AND PROVIDE THE NECESSARY STALL MARGIN AND DISTORTION TOLERANCE OVER A WIDE RANGE OF FLIGHT CONDITIONS. INCREASING STAGE PRESSURE RATIO REDUCES THE NUMBER OF BLADE ROWS NECESSARY TO PROVIDE THE OVERALL PRESSURE RATIO AND THUS REDUCE WEIGHT. A. COMPRESSOR BLADES MUST BE DESIGNED TO OPERATE AT HIGHER FLOW MACH NUMBERS ENCOUNTERED AT INCREASED ROTATIONAL SPEEDS MADE POSSIBLE BY IMPROVED MATERIALS. MULTIPLE CIRCULAR ARC AND OTHER BLADE SHAPES CAN BE SPECIFICALLY SELECTED FOR THESE HIGH LEVELS OF FLOW MACH NUMBER. B. INCREASING BLADE AERODYNAMIC LOADING WILL MAKE POSSIBLE THE USE OF FEWER BLADE ROWS TO OBTAIN A GIVEN OVERALL PRESSURE RATIO. VARIOUS APPROACHES TO DELAY END WALL STALL ARE NECESSARY TO OBTAIN SUITABLE PERFORMANCE FROM THESE HIGHLY LOADED BLADE ROWS. C. A NUMBER OF ADVANCED CONCEPTS MAY BE USEFUL IN IMPROVING COMPRESSOR PERFORMANCE AND DISTORTION TOLERANCE. VARIABLE CAMBER GUIDE VANES AND STATORS CAN BE UTILIZED TO REMATCH STAGES TO IMPROVE PERFORMANCE OVER A WIDER RANGE OF FLOW CONDITIONS. VARIOUS CASING TREATMENTS MAY BE USEFUL IN IMPROVING DISTORTION TOLERANCE AND INCREASING STALL MARGIN. A NUMBER OF THESE ADVANCED CONCEPTS FOR IMPROVING STALL MARGIN AND DISTORTION TOLERANCE MAY PROVIDE GOOD PERFORMANCE WITH HIGH ASPECT RATIO BLADING WHICH CAUSED SUBSTANTIALLY REDUCED ENGINE LENGTH AND WEIGHT. D. ADVANCED CONCEPTS ARE INVESTIGATED IN SINGLE STAGE COMPRESSORS. PROMISING CONCEPTS BEING INVESTIGATED IN MULTISTAGE COMPRESSORS INCLUDE ADVANCED BLADE SHAPES, HIGHLY LOADED BLADE ROWS, VARIABLE CAMBER BLADE ROWS, AND CASING TREATMENT CONCEPTS.

RTOP NO. 720-03-13 TITLE: COMBUSTORS AND FUELS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ROUDEBUSH, W. H. TEL. 216-433-6146
TECHNICAL SUMMARY

RESEARCH PROGRAMS WILL BE CONDUCTED IN THE AREAS OF PRIMARY COMBUSTORS, AUGMENTING BURNERS AND FUELS FOR ADVANCED TURBOJET ENGINES. THE OBJECTIVE OF THE PRIMARY COMBUSTOR PROGRAM IS TO ESTABLISH THE TECHNOLOGY NECESSARY FOR THE DESIGN OF HIGH PERFORMANCE, DURABLE COMBUSTORS FOR ADVANCED COMMERCIAL AND MILITARY APPLICATIONS. A RANGE OF COMBUSTOR PRESSURES UP TO 600 PSIA, INLET TEMPERATURES UP TO 1400 DEGREES F, AND OUTLET TEMPERATURES FROM 2400 DEGREES F TO 4000 DEGREES F WILL BE INVESTIGATED. AFTERBURNERS WILL BE EVALUATED AND IMPROVED AS REQUIRED FOR ADVANCED APPLICATIONS IN

HIGH TEMPERATURE TURBOJET AND TURBOFAN ENGINES. INVESTIGATIONS WILL BE CONDUCTED OVER RANGES OF THE PERTINENT ENGINE PARAMETERS SUCH AS TEMPERATURE, PRESSURE, VELOCITY, FUEL-AIR RATIO, BYPASS RATIO, ETC. THE EFFECTS OF THE VARIOUS AFTERBURNER DESIGN VARIABLES SUCH AS BLOCKAGE, FLAMEHOLDER GEOMETRY, FUEL MIXING LENGTH, STAGING, PILOTING, BURNER LENGTH, CORE AND BYPASS MIXING, ETC. WILL BE EVALUATED. A CONTRACT PROGRAM WILL BE CONDUCTED TO DESIGN AND TEST A REALISTIC LIQUID METHANE FUEL SYSTEM. FURTHER IN-HOUSE EVALUATION OF THIS METHANE FUEL SYSTEM PERFORMANCE WILL BE CONDUCTED IN FY 1972 USING AN AVAILABLE TURBOJET ENGINE.

RTOP NO. 720-03-14 TITLE: TURBINES
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ESGAR, J. B. TEL. 216-433-4000
TECHNICAL SUMMARY

THE TURBINE AERODYNAMICS RESEARCH WILL UTILIZE ANALYSIS AND EXPERIMENTS ON COLD AIR TURBINES TO (1) INVESTIGATE THE AERODYNAMIC EFFECTS OF COOLING AIR DISCHARGE (USING A VARIETY OF COOLING METHODS) ON TURBINE PERFORMANCE FOR BOTH SINGLE AND MULTISTAGE TURBINES, (2) INVESTIGATE THE PERFORMANCE OF BOTH FIXED AND VARIABLE GEOMETRY TURBINES, (3) INVESTIGATE A NUMBER OF METHODS OF INCREASING BLADE LOADING IN ORDER TO REDUCE TURBINE SIZE AND HEAT TRANSFER SURFACE AREA. THE TURBINE COOLING RESEARCH IS DIRECTED TOWARDS DEVELOPING METHODS FOR PREDICTING WITH A RATHER HIGH DEGREE OF CONFIDENCE THE COOLING PERFORMANCE OF AIR COOLED TURBINE BLADES COOLED BY A VARIETY OF METHODS, DEMONSTRATING THE FEASIBILITY OF OPERATING GAS TURBINES AT VERY HIGH GAS TEMPERATURES AND VERY HIGH PRESSURES DEVELOPING IMPROVED METHODS OF FABRICATING COOLED TURBINE BLADES BY MEANS OF NOVEL CONSTRUCTION METHODS, NEW MATERIALS, AND IMPROVED BONDING TECHNIQUES. BOTH THE AERODYNAMICS AND COOLING RESEARCH ARE VERY DIRECTLY APPLICABLE TO PRESENT DEVELOPMENTAL AND FUTURE AIRCRAFT ENGINES. THE TURBINE IS UNDERGOING A GREATER CHANGE THAN ANY OTHER ENGINE COMPONENT IN MODERN ENGINES. THE TURBINE INLET TEMPERATURES ARE STEADILY INCREASING AS FAST AS THE STATE-OF-THE-ART WILL PERMIT, AND HIGH WORK TURBINES ARE BEING INTRODUCED IN ORDER TO REDUCE TURBINE WEIGHT AND SIZE AND TO REDUCE THE HEAT TRANSFER SURFACE AREA IN COOLED TURBINES.

RTOP NO. 720-03-15 TITLE: TURBINE ENGINE SYSTEMS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: POVOLNY, J. H. TEL. 216-433-6624
TECHNICAL SUMMARY

THE OBJECTIVE IS TO CONTINUE TO DEVELOP THE TECHNOLOGY RELATIVE TO TURBINE ENGINE SYSTEMS REQUIRED FOR FUTURE SUPERSONIC AIRCRAFT. PARTICULAR EMPHASIS WILL BE PLACED ON SEEKING AN UNDERSTANDING AND SOLUTION OF THE DYNAMIC INTERACTION PROBLEMS ASSOCIATED WITH SUPERSONIC FLIGHT. THE LATEST LARGE SCALE TURBOJET AND TURBOFAN ENGINES DESIGNED FOR BOTH SUPERSONIC CRUISE AND SUPERSONIC DASH APPLICATIONS WILL BE USED IN THE INVESTIGATIONS. BOTH EXPLORATORY AND PERFORMANCE EVALUATIONS WILL BE MADE OF SYSTEMS APPLICABLE TO THE

SST AND MILITARY AIRPLANES CURRENTLY BEING DESIGNED. THIS EFFORT IS CONCERNED WITH THE EFFECTS OF INLET PRODUCED ENVIRONMENT ON THE ENGINE AND THE INTERACTIONS OF THE VARIOUS ENGINE COMPONENTS AS WELL AS INTERACTIONS BETWEEN THE ENGINE AND THE INLET. THIS EFFECT IS CLOSELY RELATED TO THE INLET, INLET CONTROL, AND INLET ENGINE DYNAMICS RESEARCH DESCRIBED IN RTOP 720-03-10.

RTOP NO. 720-04-10 TITLE: ATMOSPHERIC RESEARCH
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE IS TO OBTAIN DETAILED MEASUREMENTS OF THE COMPONENTS OF ATMOSPHERIC TURBULENCE AND RADIATION FROM GALACTIC AND SOLAR COSMIC RAYS IN THE ATMOSPHERE AT ALTITUDES UP TO 75,000 FEET. THE ATMOSPHERIC TURBULENCE MEASUREMENTS WILL BE MADE WITH AIRCRAFT CARRYING SUITABLE INSTRUMENTATION INCLUDING VANES AND A STABLE PLATFORM. THE INSTRUMENTED AIRPLANE WILL MAKE ENOUGH FLIGHTS (50 TO 60 FLIGHTS OVER A 2-YEAR PERIOD) TO OBTAIN STATISTICALLY RELIABLE SPECTRAL MEASUREMENTS. THE RADIATION ENVIRONMENTS IN THE ATMOSPHERE RESULTING FROM GALACTIC AND SOLAR COSMIC RAYS ARE BEING MEASURED AND EVALUATED. THESE MEASUREMENTS ARE REQUIRED BECAUSE THE INTERACTION BETWEEN THE PARTICLES AND THE ATMOSPHERE CANNOT BE PRECISELY CALCULATED AT PRESENT. THE MEASUREMENTS BEING TAKEN INCLUDE TOTAL IONIZATION AND NEUTRON FLUXES AND ENERGIES. THE BALLOON AND HIGH ALTITUDE AIRCRAFT FLIGHTS WILL BE CONTINUED OVER F.Y. 1971 AND F.Y. 1972 ESPECIALLY ALSO DURING SOLAR FLARE EVENTS. THEORETICAL AND EXPERIMENTAL NUCLEAR PHYSICS STUDIES TO DETERMINE THERORETICALLY THE PRIMARY AND SECONDARY RADIATION ENVIRONMENT WITHIN THE ATMOSPHERE AND IN SPACE VEHICLES AND OF THE DOSE EQUIVALENTS IN MAN WILL BE CONTINUED. NUCLEAR CROSS SECTION MEASUREMENTS ARE BEING CONDUCTED WITH THE PRINCETON PENNSYLVANIA ACCELERATOR, BESIDES THEORETICAL STUDIES BY THE UNIVERSITY OF PENNSYLVANIA, TO IMPROVE THE TRANSPORT CODES DEVELOPED AT LANGLEY PREDICTING PARTICLE SPECTRA AND DOSE EQUIVALENTS IN SST ALTITUDES, IN SPACE VEHICLES AND ON MARS. EVALUATION OF SPACE ENVIRONMENTAL DATA, SHIELDING AND DOSE CALCULATIONS FOR PLANNED MISSIONS, THE CONSULTING ACTIVITY TO NASA, FAA, ESSA AND OTHER AGENCIES ON THEIR MISSIONS, SPACE RADIATION PROBLEMS AND EFFECTS WILL BE CONTINUED.

RTOP NO. 720-05-10 TITLE: SUPERSONIC AIRCRAFT FLIGHT DYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: TEL. 415-961-1111
TECHNICAL SUMMARY

GROUND-BASED, PILOTED SIMULATIONS AND IN-FLIGHT PILOTED SIMULATIONS HAVE BEEN USED FOR SOME TIME IN STUDIES OF VARIOUS FACTORS (I.E., VARIATIONS IN: PARAMETERS, AUGMENTATION SYSTEMS, COCKPIT INSTRUMENTS, TURBULENT AIR, VISIBILITY, CROSS-WIND VELOCITIES, ETC.) THAT CONTRIBUTE TO THE ESTABLISHMENT OF HANDLING QUALITIES REQUIREMENTS OF SUPERSONIC AIRCRAFT DESIGNS BOTH IN THE LOW-SPEED AREAS OF LANDING APPROACH, LANDING, TAKE-OFF AND CLIMB, AND

IN THE HIGH-SPEED AREAS OF CRUISE, OVER-SPEED, ENGINE FAILURE, STABILITY AUGMENTATION SYSTEM FAILURE, ETC. THIS WORK IS DIRECTED (1) AT THE IMPROVEMENT OF TECHNOLOGY IN THIS AREA, (2) AT SUPPLYING BASIC INFORMATION USEFUL TO THE FAA IN ESTABLISHING CERTIFICATION REGULATIONS FOR SUPERSONIC TRANSPORT AIRCRAFT, AND FOR DEVELOPING REVISIONS IN CERTIFICATION TEST MANEUVERS TO PLACE THE CERTIFICATION PROCESS OF THESE AIRCRAFT ON A MORE RATIONAL BASIS, AND (3) AT SUPPLYING BASIC INFORMATION USEFUL TO MILITARY AIRCRAFT DESIGN, SUCH AS, FOR EXAMPLE, THE CARRIER LANDING APPROACH DYNAMIC REQUIREMENTS OF CARRIER FIGHTER AIRCRAFT.

RTOP NO. 720-05-10 TITLE: FLIGHT DYNAMICS
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: PERRY, J. J. TEL. 805-258-3311
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS RTOP ARE TO DEFINE CONCEPTS FOR ENHANCING THE CAPABILITIES OF THE GENERAL PURPOSE AIRBORNE SIMULATOR (GPAS) VARIABLE STABILITY AIRPLANE, TO DEVELOP THOSE CONCEPTS WHICH ARE FEASIBLE AND TO IMPLEMENT THE PRACTICAL CONCEPTS INTO THE GPAS SYSTEM. THE ULTIMATE OBJECTIVE IS TO PROVIDE THE MOST ADVANCED USA FACILITY FOR THE INVESTIGATION OF FLY CHARACTERISTICS, HANDLING QUALITIES CRITERIA AND STABILITY AUGMENTATION REQUIREMENTS FOR TRANSPORT CATEGORY AIRCRAFT. THE APPROACH IS TO DEFINE THE REQUIREMENTS FOR SYSTEMS IMPROVEMENTS, AND DESIGN MODIFICATIONS TO MEET THESE REQUIREMENTS. THE ITEMS OF PRIMARY CONCERN ARE: SIDE-FORCE GENERATOR FOR IMPROVED SIMULATION OF DIRECTIONAL COCKPIT FORCES, DIRECT LIFT CONTROL TO ENHANCE THE FIDELITY OF LONGITUDINAL SIMULATIONS, AND AN IMPROVED VARIABLE FEEL SYSTEM, AN AIR-DATA SYSTEM WITH IMPROVED ALTITUDE AND ALTITUDE RATE MEASURING DEVICES, A TURBULENCE SIMULATION CAPABILITY, UPGRADING GPAS CONTROL AND COMPUTER SYSTEMS, IMPROVING THE DATA ACQUISITION SYSTEM TO PERMIT EFFICIENT COMPUTER PROCESSING OF RESEARCH, DATA, AND EXPANSION OF THE GPAS ENVELOPE TO INCLUDE THE LANDING APPROACH CONDITION.

RTOP NO. 720-05-10 TITLE: FLIGHT DYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

TO PROVIDE HANDLING QUALITIES CRITERIA AND STABILITY AUGMENTATION REQUIREMENTS FOR SUPERSONIC AIRCRAFT BY IN-HOUSE AND CONTRACTED STUDIES. TO INCLUDE STUDIES OF THE INFLUENCE OF MINIMUM HANDLING QUALITIES REQUIREMENTS ON SUPERSONIC FIGHTER CONFIGURATIONS AND STABILITY AUGMENTATION DESIGN WITH EMPHASIS ON ACCELERATED FLIGHT. TO INCLUDE STUDIES OF REDUNDANCE TECHNIQUES IN ADAPTIVE CONTROL BY DIGITAL CONCEPTS, AND TO INCLUDE SIMULATIONS TO DETERMINE PILOT OPINIONS OF HANDLING QUALITIES IN ACCELERATED FLIGHT.

RTOP NO. 720-11-10 TITLE: FIGHTER AIRCRAFT OPTIMIZATION FOR
TRANSONIC MANEUVERABILITY

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: SISK, T. R. TEL. 805-258-3311

TECHNICAL SUMMARY

THIS PROGRAM IS A COORDINATED FLIGHT/WIND-TUNNEL INVESTIGATION OF FIGHTER AIRCRAFT TRANSONIC MANEUVERABILITY UTILIZING SUCH AIRCRAFT AS THE F-5, F-104, F-8, AND F-111A. THE INVESTIGATION INCLUDES THE EVALUATION OF EFFECTS OF MANEUVER FLAP DEFLECTION ON BUFFET ALLEVIATION AND HANDLING QUALITIES AS WELL AS VALIDATION OF MODEL RESULTS OF AERODYNAMIC INNOVATIONS SUCH AS THE NORTHROP DOUBLE-HINGED LEADING-EDGE FLAP. IT ALSO INCLUDES AN ASSESSMENT OF HIGH ANGLE-OF-ATTACK FLYING QUALITIES AND A REVIEW OF APPROPRIATE HANDLING QUALITIES CRITERIA AND SPECIFICATIONS. FLIGHT RESULTS WILL BE CLOSELY COORDINATED WITH MODEL RESULTS TO ASSIST IN DEVELOPING PREDICTION TECHNIQUES AND ESTABLISHING ADVANCE DESIGN CRITERIA.

RTOP NO. 720-52-10 TITLE: F-111 FLIGHT RESEARCH PROGRAM -
OPERATIONAL SUPPORT

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: TEL. 805-258-3311

TECHNICAL SUMMARY

THIS PROGRAM COVERS THE OPERATIONAL SUPPORT OF F-111A AIRPLANE NO. 12 (S/N 639777) WHICH IS ON LOAN TO FRC AND IS BEING USED FOR BASIC RESEARCH ON ENGINE-AIRFRAME INTEGRATION PROBLEMS. THIS RTOP COVERS MAINTENANCE AND REPAIR AND THE OPERATIONAL EFFORT OF THE AIRPLANE AND INSTRUMENT SYSTEMS AND ALSO MINOR MODIFICATIONS AND CHANGES IN THE ENGINE, AIRFRAME, AND INSTRUMENTATION.

RTOP NO. 720-53-10 TITLE: YF-12 RESEARCH PROGRAM

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: MATRANGA, G. J. TEL. 805-258-3311

TECHNICAL SUMMARY

TWO NASA FLIGHT CREWS HAVE BEEN CHECKED OUT. A/C #935. NASA RESEARCH AIRPLANE. FIRST RECHECKOUT FLIGHT WAS DECEMBER 11, 1969. ON FLIGHT 8, THE LOWER FUSELAGE VENTRAL FIN FAILED DURING A TRANSONIC SIDESLIP MANEUVER BEING FLOWN FOR HANDLING QUALITIES PILOT RATING; SIDESLIP ANGLE AT FAILURE WAS A LITTLE MORE THAN HALF THE LIMIT VALUE. SUPERFICIAL STRUCTURAL DAMAGE WAS REPAIRED AND THE AIRPLANE IS BEING FLOWN WITHOUT THE FIN AT SPEEDS BELOW MACH 2. A NEW FIN IS BEING FABRICATED. THE AIRPLANE WAS LOANED TO NASA ON APRIL 17, 1970.

FIFTEEN FLIGHTS HAVE BEEN MADE AS OF MAY 1, 1970. RESEARCH DATA BEING OBTAINED INCLUDES STRUCTURAL DEFLECTION MEASUREMENTS, PHUGOID CHARACTERISTICS, STABILITY WITHOUT THE FIN, AND ATMOSPHERIC TURBULENCE. THE AIRPLANE WILL BE SET DOWN EARLY IN JULY TO INSTALL THERMAL AND STRUCTURAL INSTRUMENTATION. FLYING IS EXPECTED TO RESUME LATE THIS FALL FOR THE STRUCTURES RESEARCH. PERFORMANCE AND PROPULSION RESEARCH WILL FOLLOW. A/C #936. JOINT NASA/USAF TEST PROGRAM TO DEVELOP MACH 3 INTERCEPT TACTICS AND RELATED DESIGN INFORMATION. FIRST RECHECKOUT FLIGHT WAS JANUARY 15, 1970. THE

PROGRAM IS CONTINUING. TEN FLIGHTS HAVE BEEN MADE AS OF MAY 1, 1970.

RTOP NO. 720-53-11 TITLE: YF-12A RESEARCH PROGRAM--DISCIPLINARY
RESEARCH

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: WATTS, J. D. TEL. 805-258-3311

TECHNICAL SUMMARY

NASA RESEARCH AIRPLANE. CURRENT AND PLANNED RESEARCH INCLUDES STRUCTURAL DEFLECTION MEASUREMENTS, PROPULSION SYSTEM/CONTROL SYSTEM INTERACTIONS, PERFORMANCE, AERODYNAMIC LOADS MEASUREMENTS, HANDLING QUALITIES, STABILITY AND CONTROL, STRUCTURAL MODE SUPPRESSION, AND TESTBED EXPERIMENTS. JOINT NASA/USAF TEST PROGRAM TO DEVELOP MACH 3 INTERCEPT TACTICS AND RELATED DESIGN INFORMATION. STABILITY AND CONTROL AND HANDLING QUALITIES RESEARCH PLANNED FOR THIS AIRPLANE.

RTOP NO. 720-53-11 TITLE: YF-12 RESEARCH

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: DUSTIN, M. TEL. 216-433-4000

TECHNICAL SUMMARY

THE OBJECTIVES ARE: 1) TO EVALUATE THE CAPABILITY OF CURRENTLY AVAILABLE COMPUTER SIMULATION TECHNIQUES TO DETERMINE DYNAMIC CHARACTERISTICS OF A HIGH MACH NUMBER AIRCRAFT, 2) TO INVESTIGATE ADVANCED CONCEPTS FOR IMPROVING THE INLET STABILITY MARGIN, AND 3) TO STUDY THE EXISTING AIRCRAFT CONTROL SYSTEMS AND INVESTIGATE ALTERNATE CONTROL METHODS WHICH CAN BOTH IMPROVE THE PROPULSION SYSTEM PERFORMANCE AND MINIMIZE PROPULSION SYSTEM-AIRFRAME INTERACTION.

RTOP NO. 720-53-11 TITLE: SUPERSONIC AIRPLANE RESEARCH PROGRAM
UTILIZING THE YF-12 AIRPLANE

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBINSON, R. G. TEL. 415-961-1111

TECHNICAL SUMMARY

THE ACCURACY WITH WHICH AIRCRAFT PERFORMANCE CAN BE PREDICTED IS A SUBJECT OF GREAT IMPORTANCE TO THE AERONAUTICAL DESIGN ENGINEER. CONSEQUENTLY, WHEN AN AIRCRAFT ACHIEVES FLIGHT STATUS IN A REGIME RELATIVELY UNEXPLORED, A COMPARISON OF ITS ACTUAL PERFORMANCE WITH PREDICTED PERFORMANCE CAN BE OF CONSIDERABLE VALUE. SUCH A COMPARISON REVEALS THE REGIONS WHERE ESTIMATION PROCEDURES AND GROUND-BASED TEST TECHNIQUES REQUIRE IMPROVEMENT, AS WELL AS INDICATING THOSE AREAS WHERE THE CURRENTLY EMPLOYED METHODS APPEAR ADEQUATE FOR DESIGN PURPOSES. IN VIEW OF THE FOREGOING, THEREFORE, A FLIGHT PROGRAM UTILIZING YF-12 AIRPLANES HAS BEEN INITIATED TO PROVIDE PERFORMANCE INFORMATION FOR COMPARISON WITH PREDICTIONS BASED ON THEORY AND DATA FROM GROUND-BASED TESTS

RTOP NO. 720-53-11 TITLE: YF-12 RESEARCH PROGRAM
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THIS PROGRAM IS PART OF THAT OF THE INTERCENTER RESEARCH PLANNING TEAM WHICH PLANS TO UTILIZE THE YF-12 AIRCRAFT IN A FLIGHT AND LABORATORY TEST PROGRAM AIMED AT IMPROVING THE STATE-OF-THE-ART IN PREDICTING THE DYNAMIC BEHAVIOR, AND PERFORMANCE IN THE MACH NUMBER 3.0 REGIME OF LARGE FLEXIBLE AIRCRAFT AND THEIR INTERACTING PROPULSION SYSTEMS. IN SUPPORT OF THIS INTERCENTER PROGRAM, THE MAJOR EFFORTS AT THE LANGLEY RESEARCH CENTER WILL BE CONCERNED WITH AEROELASTICITY AND BOUNDARY LAYERS. THE OBJECTIVES OF THE AEROELASTIC STUDIES ARE: (1) TO EVALUATE BY DIRECT CORRELATION WITH THE RESULTS OF FLIGHT TESTS, METHODS OF PREDICTING THE FREQUENCY RESPONSE FUNCTIONS OF LARGE, ELASTIC AIRCRAFT TO ATMOSPHERIC TURBULENCE, AND (2) TO INDICATE BY CORRELATION WITH RESULTS OF FLIGHT TESTS BOTH ANALYTICAL AND EXPERIMENTAL METHODS OF PREDICTING LONGITUDINAL AND LATERAL DIRECTIONAL STABILITY AND CONTROL DERIVATIVES. THE PRINCIPAL OBJECTIVE OF THE BOUNDARY LAYER RESEARCH EFFORT WILL BE TO PROVIDE PRECISE LABORATORY MEASUREMENT OF THE VARIETY OF GOVERNING PARAMETERS IN BOUNDARY LAYER DEVELOPMENT, AND TO ANALYSE AND CORRELATE THESE DATA WITH THOSE OF FLIGHT TESTS OF THE IDENTICAL TEST COMPONENT WITH A VIEW TO PROVIDING A BETTER ANALYTICAL REPRESENTATION OF THE PHYSICS OF THE SUPERSONIC BOUNDARY LAYER PROCESS.

RTOP NO. 721-01-10 TITLE: AERODYNAMICS CHARACTERISTICS OF
PROPELLERS AND ROTORS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

A CONTINUING RESEARCH EFFORT WILL BE MAINTAINED TO ASCERTAIN THE EFFECTIVENESS OF EXISTING THEORIES, EXTEND THE CAPABILITIES OF THEORETICAL METHODS, AND PROVIDE PROCEDURES FOR ANALYZING AND PREDICTING THE AERODYNAMIC AND PERFORMANCE CHARACTERISTICS OF ROTORS AND PROPELLERS. EXPERIMENTAL STUDIES WITH VARIOUS ADVANCED ROTOR AND PROPELLER CONCEPTS, INCLUDING SOME BASED ON NEW AIRFOIL TECHNOLOGY WILL BE UNDERTAKEN TO PROVIDE IMPROVED BASIC PERFORMANCE CHARACTERISTICS. ANALYSIS AND STUDY OF THE JET-FLAP ROTOR APPLICATIONS WILL BE MADE IN AN EFFORT TO BETTER UNDERSTAND AND OFFSET JET-DRIVE POWER LOSSES BY IMPROVED LIFT DISTRIBUTION AND WAKE INTERACTIONS. EXPERIMENTAL STUDIES WILL BE MADE OF VARIOUS PROMISING V/STOL AIRCRAFT CONFIGURATIONS, SUCH AS TILT PROP-ROTOR, UNLOADED ROTOR AND STOPPED ROTOR TYPES IN BOTH HOVERING AND HIGH SPEED FLIGHT REGIMES. PARTICULAR EMPHASIS WILL BE PLACED ON THOSE AREAS WHICH MAY PROVIDE IMPROVEMENTS IN HOVER AND HOT WEATHER PERFORMANCE, PROPELLER AND ROTOR NOISE, PARTICULARLY BLADE SLAP AND VIBRATORY AIRLOADS.

RTOP NO. 721-01-10 TITLE: AERODYNAMIC CHARACTERISTICS OF
PROPELLERS, ROTORS AND ROTORCRAFT
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBINSON, R. G. TEL. 415-961-1111
TECHNICAL SUMMARY

A JOINT NASA/ARMY PROGRAM IS DIRECTED TOWARD A "JET-FLAP" HELICOPTER ROTOR, IN WHICH A SHEET OF AIR IS BLOWN FROM THE TRAILING EDGE OF THE ROTOR BLADES, AND IN WHICH PITCH CONTROL IS OBTAINED THROUGH DEFLECTION OF THE "JET-FLAP". THE INVESTIGATION CONSISTS OF ANALYTICAL STUDIES AND STATIC AND WIND-TUNNEL TESTS. THIS METHOD OF PROPULSION AND CONTROL OFFERS THE POSSIBILITY OF REDUCED COMPLEXITY, HIGHER SPEEDS, AND LESS VIBRATION THAN WITH PRESENT TECHNOLOGY. THE PRACTICAL ASPECTS OF INCORPORATING THE "JET-FLAP" ROTOR INTO A COMPLETE VEHICLE ARE BEING INVESTIGATED. VARIOUS STOPPABLE ROTOR CONFIGURATIONS ARE BEING INVESTIGATED BY ANALYTICAL STUDIES AND IN THE WIND TUNNEL. THESE INCLUDE MEASUREMENTS OF ROTOR LOADS AND SHAFT MOMENTS AT VARIOUS COMBINATIONS OF ANGLE OF ATTACK AND ADVANCE RATIOS TO DETERMINE APPROPRIATE ROTOR CONTROL TECHNIQUES TO BE USED DURING THE ROTOR START-STOP PROCESS. THE WORK IS A COOPERATIVE EFFORT BY NASA AND THE ARMY. VARIOUS V/STOL AIRCRAFT PROPELLERS ARE BEING INVESTIGATED IN THE WIND TUNNEL, IN COOPERATION WITH AIR FORCE PROPELLER PROGRAMS, TO OBTAIN CHARACTERISTICS OF V/STOL AIRCRAFT PROPELLERS AND TO OBTAIN DATA FOR COMPARISON OF PROPELLER CHARACTERISTICS WITH PREDICTION BY ANALYTICAL METHODS.

RTOP NO. 721-01-11 TITLE: V/STOL AND STOL AERODYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE BASIC RESEARCH OBJECTIVE IS TO DEVELOP THE TECHNOLOGY REQUIRED FOR IMPROVED PERFORMANCE AND STABILITY AND CONTROL OF VTOL AND STOL AIRCRAFT CONFIGURATIONS THAT WOULD HAVE APPLICATION IN MILITARY AND CIVIL TRANSPORT AND IN MILITARY FIGHTER AND ATTACK MISSIONS. THE RESEARCH IS DIRECTED TOWARD EXPERIMENTALLY DETERMINING THE AERODYNAMIC CHARACTERISTICS OF THE MORE NOVEL TYPES OF VEHICLES INVOLVED WITH A VIEW TOWARD DEFINING THEIR GROSS CHARACTERISTICS, THE PERTINENT VARIABLES, AND THE PROBLEM AREAS AND GENERAL METHODS OF SOLUTION. WIND-TUNNEL STUDIES WILL BE USED TO IMPROVE THE CAPABILITY TO PREDICT THE AERODYNAMIC PERFORMANCE AND STABILITY AND CONTROL CHARACTERISTICS OF TURBOPROP, AND TURBOJET POWERED VTOL AND STOL CONCEPTS AS THEY ARE PRESENTLY ENVISIONED, AND TO EXPLORE NEW AIRFRAME-PROPULSION INTEGRATION CONCEPTS AIMED AT IMPROVEMENT IN PERFORMANCE.

RTOP NO. 721-03-10 TITLE: ADVANCED LIFT FANS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: LIEBLEIN, S. TEL. 216-433-4000
TECHNICAL SUMMARY

THE OBJECTIVE OF THE EFFORT IS TO PROVIDE DESIGN AND PERFORMANCE DATA, AND EXPLORE ADVANCED CONCEPTS FOR INTEGRATED PROPULSION SYSTEMS

APPLICABLE TO THE MAJOR CIVILIAN AND MILITARY VTOL MISSIONS. THE PRIMARY APPLICATION CONSIDERED FOR VTOL IS A CIVIL AIR TRANSPORTATION SYSTEM SUITABLE FOR INTERCITY SERVICE. PRINCIPAL EMPHASIS WILL BE PLACED ON HIGH-BYPASS-RATIO LIFT FAN PROPULSION SYSTEMS. RESEARCH ON LIFT FAN SYSTEM INTEGRATION EFFECTS WILL INVOLVE ANALYTICAL STUDIES AND MODEL TESTS IN THE 9 FEET X 15 FEET V/STOL TUNNEL. THE EFFORT WILL STRESS INVESTIGATION OF ADVANCED INSTALLED FAN DESIGNS AND EFFECTS OF AIRCRAFT INTEGRATION ON PROPULSION DESIGN REQUIREMENTS AND PERFORMANCE.

RTOP NO. 721-03-10 TITLE: JET-LIFT ENGINES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE BROAD OBJECTIVE IS TO DEVELOP THE TECHNOLOGY REQUIRED FOR THE ALLEVIATION OF HOT EXHAUST GAS REINGESTION BY V/STOL AIRCRAFT WHICH CAUSES SERIOUS LOSS IN ENGINE THRUST FOR V/STOL OPERATION AND MAY EVEN CAUSE FAILURE OF THE ENGINE TO CONTINUE TO OPERATE. SPECIFIC OBJECTIVES ARE TO DEFINE THE PROBLEM AND THE GENERAL MECHANISM INVOLVED, TO DEVELOP PROCEDURES FOR INVESTIGATION AT MODEL SCALE, AND TO DEVISE AIRCRAFT CONFIGURATION FIXES AND OPERATIONAL TECHNIQUES TO ALLEVIATE THE INGESTION. THE APPROACH IS MODEL-SCALE TESTING, LIMITED LARGE-SCALE TESTING FOR CORRELATION WITH THE MODEL TESTS, AND THEORETICAL ANALYSIS. THE TESTS WILL BE CARRIED OUT FOR A RANGE OF ENGINE INLET AND NOZZLE LOCATIONS, AND FOR A RANGE OF OPERATING CONDITIONS OF RELATIVE WIND AND TAKE-OFF PATHS.

RTOP NO. 721-03-12 TITLE: STOL PROPULSION SYSTEMS RESEARCH
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: LUIDENS, R. W. TEL. 216-433-4000
TECHNICAL SUMMARY

THE NASA STOLL TRANSPORT PROGRAM IS DIRECTED AT PROVIDING THE TECHNOLOGY NECESSARY TO PERMIT STOL AIRCRAFT TO BECOME OPERATIONAL AS SOON AS POSSIBLE. THE PRINCIPAL SYSTEMS OF PROPULSION-AUGMENTED LIFT WHICH ARE UNDER CONSIDERATION FOR STOL AIRCRAFT ARE (A) EXTERNALLY BLOWN FLAPS, AND (B) THE AUGMENTOR WING (INTERNALLY BLOWN JET FLAPS), BOTH USED IN CONJUNCTION WITH TURBOFAN ENGINES. HOWEVER, OTHER PROPULSION-AUGMENTED LIFT SYSTEMS HAVE POTENTIAL FOR STOL APPLICATIONS WHICH WARRANT INVESTIGATION AND EVALUATION. THE OBJECTIVES OF THE PROGRAM UNDER THIS RTOP ARE (A) TO INVESTIGATE THE POTENTIAL OF WING LIFT AUGMENTATION THROUGH THE USE OF MULTIPLE FANS MOUNTED ALONG THE WING SPAN AND BLOWING INTO, OR MOUNTED ON, MOVABLE FLAPS; (B) TO INVESTIGATE THE PERFORMANCE OF THE EXTERNALLY BLOWN FLAP WITH LOW PRESSURE RATIO FANS; AND (C) TO INVESTIGATE MEANS OF ALLEVIATING "ENGINE OUT" PROBLEMS WITH THE EXTERNALLY BLOWN FLAP. THE PROGRAM CONSISTS PRIMARILY OF INVESTIGATIONS OF SCALE MODELS OF VARIOUS CONFIGURATIONS IN THE 9' X 15' V/STOL TEST SECTION OF THE 8' X 6' SWT.

RTOP NO. 721-03-13 TITLE: LIFT FAN COMPONENT AND ENGINE TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: STEWART, W. L. TEL. 216-433-4000
TECHNICAL SUMMARY

THE VTOL TRANSPORT PROGRAM CONSISTS OF THREE PHASES: PHASE I (4 YEARS), RESEARCH LEADING TO THE SELECTION OF THE PROPULSION SYSTEM AND AIRCRAFT CONFIGURATION, AS WELL AS PROVIDING AN ASSOCIATED TECHNOLOGY BASE. PHASE II (3 YEARS) CONSTRUCTION AND TESTING OF SELECTED PROPULSION SYSTEM AND AIRCRAFT MODEL, AND PHASE III (3 YEARS) FINAL DESIGN, CONSTRUCTION AND FLIGHT TESTS OF COMPLETE AIRCRAFT. THE FUTURE OF SUCH AIRCRAFT DEPENDS TO A GREAT EXTENT UPON THE EVOLVING OF SUITABLE LIFT OR LIFT/CRUISE POWER PLANTS. THESE MUST HAVE REASONABLY LOW SFC AND BE LIGHTWEIGHT, QUIET, AND REASONABLE IN COST. THE TECHNOLOGY PROGRAM UNDER THIS RTOP IS DIRECTED AT THE INVESTIGATION OF PROBLEMS ASSOCIATED WITH COMPONENTS OF THE ENGINES SUITABLE FOR EVENTUAL USE IN THIS APPLICATION AS WELL AS PACKAGES WHERE THE PROBLEMS TO BE EXPLORED REQUIRE CERTAIN COMPONENT INTEGRATION. THE DESIGN STUDY OF COMPLETE ENGINES ARE ALSO TO BE CONDUCTED TO PROVIDE INPUT INTO THE TECHNOLOGY PROGRAM AS WELL AS INFORMATION REQUIRED IN THE STUDY OF APPROPRIATE AIRCRAFT TO BE MADE UNDER ANOTHER RTOP. PRINCIPAL ENGINE CONFIGURATIONS OF INTEREST INCLUDE REMOTE DRIVE (WITH BOTH TIP AND HUB TURBINES) AND INTEGRAL DRIVE (CONVENTIONAL TURBOFAN) SYSTEMS. THE NEAR TERM OBJECTIVES OF THE PROGRAM ARE CONSISTENT WITH THOSE OF PHASE I OF THE TRANSPORT PROGRAM DESCRIBED ABOVE.

RTOP NO. 721-03-14 TITLE: GEARS, SHAFTING AND ROTOR DYNAMICS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ANDERSON, W. J. TEL. 216-433-4000
TECHNICAL SUMMARY

MATERIALS, FABRICATION TECHNIQUES, DESIGNS AND LUBRICATION TECHNIQUES FOR GEARING WILL BE DEVELOPED. ANALYTIC TECHNIQUES FOR BALANCING, AND DETERMINING AND CONTROLLING THE DYNAMIC BEHAVIOR OF SHAFTS AND ROTORS WILL BE DEVELOPED AND CORROBORATED EXPERIMENTALLY TO PROVIDE BETTER DESIGN TOOLS FOR HIGH SPEED TURBOMACHINERY, SHAFTING AND TRANSMISSIONS.

RTOP NO. 721-04-10 TITLE: V/STOL NOISE REDUCTION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO PROVIDE INFORMATION NECESSARY FOR THE DESIGN OF V/STOL VEHICLES HAVING ACCEPTABLE NOISE CHARACTERISTICS. PROPULSION SYSTEM COMPONENTS, WHICH ARE PARTICULARLY APPLICABLE TO V/STOL VEHICLES, SUCH AS HELICOPTER MAIN AND TAIL ROTORS, TILTABLE PROPELLERS, DEFLECTED JETS, LIFT JETS, LIFT FANS, AND JET FLAPS WILL BE CONSIDERED, AS WELL AS THE APPLICATION OF NOISE REDUCTION MATERIALS AND SUPPRESSORS. THIS WORK WILL BE ACCOMPLISHED BY MEANS OF THEORETICAL STUDIES AND BOTH MODEL AND FULL-SCALE TESTS INVOLVING VEHICLES IN FLIGHT, WIND TUNNELS, TEST

STANDS, AND SPECIAL ACOUSTIC TEST CELLS, FACILITIES AND EQUIPMENT. BOTH IN-HOUSE AND CONTRACT WORK WILL BE SUPPORTED.

RTOP NO. 721-05-10 TITLE: V/STOL AND STOL AIRCRAFT FLIGHT DYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-916-1111
TECHNICAL SUMMARY

GROUND-BASED SIMULATORS, VARIABLE STABILITY AIRCRAFT, VARIOUS CONCEPTUAL TYPES OF AIRCRAFT, ESPECIALLY EQUIPPED AIRCRAFT, AND ANALYTICAL STUDIES ARE USED TO EXTEND KNOWLEDGE OF V/STOL AIRCRAFT FLIGHT DYNAMICS REQUIREMENTS AND MEANS OF MEETING THE REQUIREMENTS. GROUND-BASED SIMULATION IS USED TO STUDY A WIDE VARIATION OF SYSTEM PARAMETERS THAT AFFECT FLIGHT DYNAMICS, AND FLIGHT OF ACTUAL AIRCRAFT IS USED TO VERIFY DISCRETE POINTS. RESULTS ARE ANALYZED AS TO THEIR RELATION TO FAA CERTIFICATION OF V/STOL AIRCRAFT. THE STUDIES INCLUDE THE RELATION OF COCKPIT DISPLAYS AND HUMAN OPERATOR CONTROL CHARACTERISTICS AND PERFORMANCE AS PART OF THE COMPLETE FLIGHT DYNAMICS SYSTEM, AND ARE INTIMATELY RELATED TO OPERATIONS UNDER INSTRUMENT CONDITIONS, PARTICULARLY UNDER TERMINAL AREA GUIDANCE FOR LANDING AND TAKEOFF. THE MOVING CAB TRANSPORT SIMULATOR AND THE SIX-DEGREE-OF-FREEDOM MOTION SIMULATOR ARE THE GROUND-BASED SIMULATORS USED TO STUDY A WIDE RANGE OF SYSTEM PARAMETERS. THE X-14 VARIABLE STABILITY VTOL AIRCRAFT PROVIDES FLIGHT VERIFICATION OVER CONSIDERABLE RANGE OF PARAMETERS. THE XV-5B FAN-IN-WING AIRCRAFT PERMITS STUDY OF THE RELATION OF THE OPERATIONAL ENVELOPE OF THIS CONCEPT OF AIRCRAFT TO THE EASE OF PERFORMING PRECISE APPROACHES FOR TERMINAL AREA OPERATIONS. A C-8A AIRCRAFT IS BEING USED PARTICULARLY FOR STUDIES TO DEVELOP CERTIFICATION CRITERIA AND TO DEFINE GUIDANCE AND DISPLAY REQUIREMENTS FOR IFR STOL OPERATIONS. THE HUNTING-126 JET-FLAP AIRCRAFT WILL BE INVESTIGATED TO PROVIDE DATA ON THE AERODYNAMICS, AND STABILITY AND CONTROL CHARACTERISTICS THAT WILL BE USEFUL IN THE DESIGN OF JET-POWERED STOL AIRCRAFT.

RTOP NO. 721-05-10 TITLE: V/STOL AND STOL FLIGHT CHARACTERISTICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

V/STOL AIRCRAFT HAVE THE POTENTIAL FOR SAFE FOUL-WEATHER OPERATION, EVEN INTO SMALL AREAS AS ON TO ROOFTOPS IN CONGESTED LOCATIONS. TACTICAL V/STOL AIRCRAFT, BOTH JET AND ROTOR TYPES, HAVE THE POTENTIAL FOR USE OF THEIR VERTICAL-LIFT CHARACTERISTICS IN TACTICAL OPERATIONS TO ENHANCE MISSION CAPABILITY. CONVENTIONAL OPERATING TECHNIQUES, CURRENT MANEUVER LIMITATIONS, CURRENTLY AVAILABLE INSTRUMENTATION AND GUIDANCE PRACTICES, AND THE GENERAL FLIGHT CHARACTERISTICS OF EXISTING V/STOL VEHICLES DO NOT PRESENTLY PERMIT ADEQUATE REALIZATION OF THESE POTENTIALS. THE RESEARCH PROJECTS WILL PROVIDE THE BACKGROUND KNOWLEDGE NEEDED TO ESTABLISH V/STOL OPERATIONAL REQUIREMENTS WITH RESPECT TO THE AIRCRAFT CONTROL AND STABILITY, FLIGHT CONTROL SYSTEM CHARACTERISTICS, MANEUVER ENVELOPES AND LIMITATIONS, GUIDANCE INFORMATION, COCKPIT DISPLAYS,

AIRSPACE REQUIREMENTS, PILOTING TECHNIQUES AND WORKLOADS. PARTICULAR EMPHASIS WILL BE ON THE OPERATIONAL REQUIREMENTS FOR CONVERSION FROM WING-BORNE TO POWERED-LIFT FLIGHT AND INFLIGHT DECELERATION TO LOW TOUCHDOWN SPEEDS OR HOVER DURING PRECISION GUIDED INSTRUMENT APPROACHES TO THE LANDING AREA AND IN IMPROVING THE ABILITY TO PREDICT AND REALIZE SATISFACTORY MANEUVER ENVELOPES AS DICTATED BY OPERATIONAL REQUIREMENTS. ANALYTICAL, SIMULATION, WIND-TUNNEL, AND FLIGHT STUDIES WITH AVAILABLE VEHICLES WILL BE MADE TO ACCUMULATE THE DATA AND UNDERSTANDING REQUIRED TO ESTABLISH APPROPRIATE CRITERIA AND POSSIBLE MEANS FOR IMPROVED FLIGHT CHARACTERISTICS FOR THE VARIOUS V/STOL AIRCRAFT CONCEPTS.

RTOP NO. 721-05-11 TITLE: V/STOL AND STOL FLIGHT CHARACTERISTICS
ORGANIZATION: HEADQUARTERS
MONITOR: KAYTEN, G. G. TEL. 202-963-7335
TECHNICAL SUMMARY

FLIGHT AND GROUND-BASED SIMULATION RESEARCH IS BEING CARRIED OUT BY AMES AND LANGLEY WITH V/STOL AIRCRAFT TO STUDY HANDLING-QUALITIES AND TERMINAL-AREA OPERATION PROBLEMS OF SUCH AIRCRAFT. AS PART OF THE OVERALL INVESTIGATION, THE NAVY X-22 TILT-DUCT, V/STOL AIRPLANE IS BEING UTILIZED IN A PROGRAM FUNDED BY THE NAVY, AIR FORCE AND NASA. THE X-22 HAS A WIDER ALLOWABLE DESCENT ENVELOPE THAN MOST OTHER VTOL AIRCRAFT (SUCH AS THE XC-142A) AND REDUCED CRUISE-TO-APPROACH CREW WORKLOAD REQUIREMENTS. THESE TWO SIGNIFICANT FACTORS OF THE X-22 MAKE THIS AIRCRAFT PARTICULARLY SUITABLE FOR EXTENDING THE TERMINAL AREA OPERATIONS RESEARCH ALREADY PERFORMED TO DETERMINE MINIMUM AIRSPACE REQUIREMENTS AND ASSOCIATED TERMINAL AREA FLIGHT PROCEDURES FOR IFR OPERATIONS.

RTOP NO. 721-06-10 TITLE: V/STOL AIRCRAFT SUPPORT
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

MAINTENANCE AND OPERATION OF AIRCRAFT FOR V/STOL RESEARCH PROGRAMS.

RTOP NO. 721-06-10 TITLE: VTOL AND STOL AIRCRAFT SUPPORT
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-1111
TECHNICAL SUMMARY

THE FOLLOWING AIRCRAFT ARE USED IN FLIGHT INVESTIGATIONS OF VTOL AND STOL AIRCRAFT 1. X-14B JET-LIFT VTOL AIRCRAFT WITH A THREE AXIS MODEL FOLLOWING VARIABLE-STABILITY SYSTEM. 2. XV-5B FAN-IN-WING VTOL AIRCRAFT 3. C-8A STOL AIRCRAFT 4. UH-12E HELICOPTER 5. OV-10B STOL AIRCRAFT MODIFIED TO INCORPORATE A ROTATING CYLINDER FLAP 6. HU-1 HELICOPTER.

RTOP NO. 721-07-10 TITLE: ANALYSIS OF CIVIL V/STOL TRANSPORT
RESEARCH AIRCRAFT REQUIREMENTS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THIS RTOP WILL COVER LANGLEY EFFORTS IN DETERMINING THE MANNER AND EXTENT TO WHICH V/STOL TECHNOLOGY CAN BE APPLIED TO IMPROVE THE SHORT-HAUL AIR TRANSPORTATION SITUATION IN THIS COUNTRY. THE PROGRAM WILL USE IN-HOUSE RESEARCH AND ANALYSIS AND CONTRACT STUDIES, TO DETERMINE, THE MORE PROMISING TRANSPORTATION IMPROVEMENTS POSSIBLE WITH V/STOL TECHNOLOGY.

RTOP NO. 721-51-10 TITLE: ROTATING CYLINDER FLAP RESEARCH AIRCRAFT,
OV-10B

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, L. TEL. 415-961-1111

TECHNICAL SUMMARY

THE PROGRAM IS A JOINT NASA/ARMY EFFORT TO DETERMINE, IN FLIGHT, THE PREDICTED CHARACTERISTICS OF THE ROTATING CYLINDER FLAP CONCEPT AS APPLIED TO PROPELLER-DRIVEN AIRCRAFT OF RELATIVELY LOW GROSS WEIGHTS AND WING LOADINGS, AND TO DEFINE AND RESOLVE OPERATIONAL PROBLEMS. MODIFICATIONS ARE TO BE MADE TO THE AMES OV-10B AIRCRAFT TO MEET THE PROGRAM OBJECTIVES; THE MODIFICATIONS CONSIST OF A ROTATING-CYLINDER FLAP SYSTEM LARGER ENGINES, PROPELLER INTERCONNECT, AND IMPROVED LOW-SPEED CONTROLS. THE STEPS IN THE PROGRAM ARE (1) WIND-TUNNEL TESTS OF A LARGE SCALE MODEL TO PROVIDE DETAILED AERODYNAMIC DESIGN INFORMATION, (2) DESIGN FEASIBILITY STUDY UNDER CONTRACT, (3) DETAILED DESIGN, FABRICATION OF COMPONENTS, MODIFICATION OF AIRCRAFT, GROUND AND WIND-TUNNEL TESTS OF MODIFIED AIRCRAFT, AIRWORTHINESS FLIGHT TESTS BY CONTRACTOR, AND (4) A PROOF-OF-CONCEPT FLIGHT RESEARCH PROGRAM (CONSISTING OF (A) DETERMINATION OF THE AERODYNAMIC PERFORMANCE OF THE ROTATING-CYLINDER FLAP CONCEPT, AND (B) A STUDY OF THE STABILITY, CONTROL AND HANDLING QUALITIES OF THE MODIFIED AIRCRAFT.). THE PROGRAM IS BEING UNDERTAKEN BECAUSE OF THE NEED FOR PROPELLER STOL AIRCRAFT TO SOLVE BOTH CIVIL AND MILITARY AIR TRANSPORTATION PROBLEMS. THE ROTATING-CYLINDER FLAP CONCEPT HAS BEEN SELECTED BECAUSE THE RESULTS OF WIND-TUNNEL INVESTIGATIONS OF ADVANCED HIGH-LIFT DEVICES FOR PROPELLER STOL AIRCRAFT HAVE SHOWN THAT THE CONCEPT IS AS EFFECTIVE AS THE MOST EFFECTIVE BOUNDARY-LAYER-CONTROL FLAP AND REQUIRES LESS POWER AT THE REQUIRED TAKE-OFF AND APPROACH SPEEDS.

RTOP NO. 721-52-10 TITLE: JET-AUGMENTOR WING RESEARCH AIRCRAFT, C-8A
ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, L. TEL. 415-961-1111

TECHNICAL SUMMARY

THE C-8A AIRCRAFT WILL BE MODIFIED TO INCORPORATE THE AUGMENTOR-WING HIGH-LIFT CONCEPT AND JET ENGINES TO PROVIDE A PROOF OF THE CONCEPT FOR PROVIDING THE TAKEOFF AND LANDING PERFORMANCE REQUIRED FOR FAN-JET STOL TRANSPORT AIRCRAFT, AND TO MAKE AVAILABLE

AN AIRCRAFT FOR CARRYING OUT LONG TERM RESEARCH ON THE JET STOL TYPE OF AIRCRAFT. THE MODIFIED AIRCRAFT IS EXPECTED TO HAVE THE CAPABILITY OF LANDING AND TAKEOFF AT SPEEDS OF 65 TO 70 KNOTS REQUIRED FOR A STOL BALANCED FIELD LENGTH OF 1500 FEET. THE AIRCRAFT WILL HAVE THE PERFORMANCE AND CONTROL CHARACTERISTICS REQUIRED TO ALLOW FLIGHT INVESTIGATIONS OF TAKEOFF AND LANDING APPROACH PROFILES AND PROCEDURES FOR MINIMIZING NOISE OR HOVER TIME. THE PROGRAM IS A COOPERATIVE EFFORT BY NASA AND THE CANADIAN GOVERNMENT THAT HAS BEEN UNDERWAY SINCE 1965. THE PROGRAM ENCOMPASSES ANALYTICAL STUDIES, WIND-TUNNEL INVESTIGATIONS GROUND-BASED SIMULATION STUDIES, DESIGN FEASIBILITIES STUDIES, DETAIL DESIGN AND MODIFICATION OF AIRCRAFT, AND FLIGHT INVESTIGATIONS. THE PROGRAM WILL PROVIDE MUCH NEEDED INFORMATION FOR THE DESIGNERS OF FAN-JET STOL AIRCRAFT WHICH THE NASA SHORT-HAUL V/STOL TRANSPORT STUDIES SHOWED TO BE ONE OF TWO V/STOL CONCEPTS THAT HAD THE LOWEST DIRECT OPERATING COSTS FOR 500-MILE RANGE COMMERCIAL TRANSPORTS.

RTOP NO. 721-52-11 TITLE: JET AUGMENTOR WING STOL AIRCRAFT
AERODYNAMICS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, L. TEL. 415-961-1111

TECHNICAL SUMMARY

RESEARCH IS UNDERWAY ON THE AERODYNAMIC AND PROPULSION INTEGRATION CHARACTERISTICS OF JET-AUGMENTED-WING, HIGH-LIFT CONFIGURATIONS, INCLUDING THE EFFECTS OF NOISE REDUCTION MODIFICATIONS ON THE AERODYNAMIC AND PROPULSION CHARACTERISTICS. THE RESEARCH IS BEING CONDUCTED BY A VARIETY OF ANALYTICAL STUDIES, SMALL-SCALE TESTS WHERE APPLICABLE IN THE AMES 7- BY 10-FOOT WIND TUNNEL AND OTHER WIND TUNNELS, AND LARGE SCALE STUDIES USING THE 40-BY 80-FOOT WIND TUNNEL. THE INVESTIGATIONS ARE BEING CARRIED OUT TO PROVIDE BACKGROUND TECHNOLOGY FOR STOL AIRCRAFT DESIGN AND TO DEVELOP ANALYTICAL METHODS FOR PREDICTING AERODYNAMIC AND PROPULSIVE INTERACTION EFFECTS.

RTOP NO. 721-52-12 TITLE: JET-AUGMENTOR WING STOL TECHNOLOGY
TRANSPORT

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, L. TEL. 415-961-1111

TECHNICAL SUMMARY

WORK WILL BE INITIATED THAT WILL LEAD TO THE DEVELOPMENT AND FLIGHT EVALUATION OF A JET AUGMENTOR WING STOL TRANSPORT AIRCRAFT. THIS VEHICLE WILL BE USED TO DEMONSTRATE THE CAPABILITY OF STOL TECHNOLOGY IN PROVIDING FAST, RELIABLE, ECONOMIC, AND SAFE AIRCRAFT AND SYSTEMS FOR SHORT- AND MEDIUM-RANGE AIR TRANSPORTATION. PRELIMINARY DESIGN AND CONTRACT DEFINITION STUDIES WILL BE CARRIED OUT BY TWO SEPARATE CONTRACTORS, WITH WIND-TUNNEL AND SIMULATION SUPPORT BY NASA AS REQUIRED. ANALYSIS AND EXPERIMENTS WILL BE CONDUCTED TO DETERMINE METHODS OF REDUCING NOISE LEVELS OF THE AUGMENTOR WING JET FLAP. THESE EFFORTS WILL BE FOLLOWED BY DETAILED DESIGN, CONSTRUCTION, AND FLIGHT EVALUATION OF THE AIRCRAFT. THE

FLIGHT INVESTIGATION WILL INCLUDE TESTS AT LOW SPEEDS ASSOCIATED WITH LANDING AND TAKEOFF OF STOL AIRCRAFT, AS WELL AS THE TRANSITION TO CRUISE FLIGHT AND THE RELATIVELY HIGH-CRUISE SPEEDS. THIS AIRCRAFT WILL BE USED TO DEMONSTRATE SYSTEM PERFORMANCE HANDLING AND RIDE QUALITIES, ENGINE-OUT PERFORMANCE, IFR CAPABILITIES AND PERCEIVED NOISE UNDER ALL FLIGHT CONDITIONS CONTEMPLATED FOR FUTURE STOL TRANSPORT AIRCRAFT.

RTOP NO. 721-56-10 TITLE: LIFT-FAN TRANSPORT PROPULSION SYSTEM
ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: STEWART, W. L. TEL. 216-433-4000

TECHNICAL SUMMARY

NASA IS ENGAGED IN A PROGRAM DIRECTED AT THE INVESTIGATION OF THE COMMERCIAL V/STOL AIRCRAFT EMPLOYING DIRECT LIFT FAN ENGINES. AS PART OF THIS PROGRAM A RESEARCH AIRCRAFT EMPLOYING ENGINES OF THIS TYPE IS TO BE STUDIED, INITIALLY IN THE STOL MODE AND ULTIMATELY IN THE VTOL MODE, TO DETERMINE ITS HANDLING, RESPONSE, OPERATIONAL, NOISE AND OTHER CHARACTERISTICS THAT ARE IMPORTANT IN ASSESSING THE POTENTIAL OF THE CONCEPT FOR COMMERCIAL OPERATION. THE AIRCRAFT EMPLOYED WILL BE A MODIFICATION OF A CURRENT SHORT HAUL COMMERCIAL TRANSPORT USING FAN ENGINES CONSIDERED AS REPRESENTING THE TYPE MOST SUITABLE. RESPONSIBILITY FOR THE AIRCRAFT PROGRAM IS AT THE PROJECT LEAD CENTER, AMES (RTOP 56-10 AMES). THE LIFT AND CRUISE FAN ENGINES ARE THE RESPONSIBILITY OF LEWIS AND ARE COVERED UNDER THIS RTOP. THE PROGRAM INCLUDES: (A) COMPLETION OF DESIGN STUDIES CURRENTLY UNDERWAY TO DETERMINE THE ENGINE TYPE BEST SUITED TO THE PROGRAM, (B) SUPPORT ACTIVITIES ASSOCIATED WITH THESE STUDIES THAT WILL AID IN ULTIMATE ENGINE SELECTION, AND (C) UPON COMPLETION OF THESE AIRCRAFT AND ENGINE DESIGN STUDIES AND SELECTION OF THE ENGINE SYSTEM TO BE USED IN THE RESEARCH VEHICLE, CONDUCTING THE NECESSARY DEVELOPMENT EFFORT TO PROVIDE THE REQUIRED LIFT AND CRUISE ENGINES FOR THIS AIRCRAFT.

RTOP NO. 721-56-10 TITLE: ADVANCED LIFT-FAN AIRCRAFT

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, I. TEL. 415-961-1111

TECHNICAL SUMMARY

A CONTRACT HAS BEEN AWARDED TO MCDONNELL DOUGLAS FOR ENGINEERING STUDIES TO IDENTIFY ADVANCED LIFT-FAN CONTROL SYSTEMS AND DETERMINE FEASIBILITY OF MODIFYING VARIOUS EXISTING CANDIDATE AIRCRAFT INTO PROOF-OF-CONCEPT V/STOL LIFT-FAN RESEARCH AIRCRAFT. THE EFFORT INCLUDES STUDY OF METHODS FOR INTEGRATING ADVANCED CONTROL SYSTEMS, AIRFRAME AND ADVANCED LIFT-FAN PROPULSION SYSTEMS. THIS CONTRACT, ORIGINALLY ORIENTED TOWARDS MODIFICATION OF THE XV-5 AIRCRAFT, HAS BEEN REDIRECTED AND EXTENDED TO INCLUDE CONSIDERATION OF LARGER EXISTING TRANSPORT AIRCRAFT AS POSSIBLE CANDIDATES FOR MODIFICATION. THE AIRCRAFT WHICH WILL BE CHOSEN AS A RESULT OF THIS STUDY WILL BE USED IN A PROGRAM TO EXAMINE THE TAKE-OFF AND LANDING APPROACH CHARACTERISTICS OF THE LIFT-FAN TYPE OF VTOL AIRCRAFT, AND THE ACCOMPANYING HANDLING QUALITIES AND NOISE CHARACTERISTICS. IN

PARTICULAR, INVESTIGATIONS WILL BE MADE OF TAKE-OFF AND LANDING APPROACH PROFILES AND PROCEDURES UNDER BOTH VFR AND IFR CONDITIONS THAT WILL ALLOW SHORT-TIME PERIODS, MINIMUM NOISE LEVELS, AND OPERATION IN UNUSED AIR AND GROUND SPACE AT MAJOR TERMINAL AREAS. THE ADVANCED QUIET LIFT FANS WILL OPERATE AT A PRESSURE RATIO OF ABOUT 1.3, AND WILL PROVIDE HIGHER THRUST-TO-WEIGHT, AND THRUST-TO-VOLUME RATIOS, AND LOWER SIDELINE NOISE LEVELS THAN THE PRESENT XV-5B FANS. THE MODIFICATIONS TO THE CONTROL SYSTEM WILL PROVIDE INCREASED CONTROL EFFECTIVENESS AND IMPROVED THRUST VECTORING CAPABILITY WITH LESS POWER REQUIRED FROM THE GAS GENERATORS. THE LIFT-FAN V/STOL TRANSPORT APPEARS TO BE ONE OF THE MOST PROMISING CONCEPTS FOR MEETING THE NATION'S CIVIL-MILITARY TRANSPORTATION NEEDS.-----

RTOP NO. 721-56-11 TITLE: LIFT-FAN TRANSPORT AERODYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

RESEARCH IS UNDERWAY ON THE AERODYNAMIC AND PROPULSION INTEGRATION CHARACTERISTICS OF DUCTED-FAN AND LIFT-FAN CONFIGURATIONS. THE RESEARCH IS BEING CONDUCTED BY A VARIETY OF ANALYTICAL STUDIES, SMALL-SCALE TESTS WHERE APPLICABLE IN THE AARL 7-BY 10-FOOT WIND TUNNEL AND OTHER WIND TUNNELS, AND LARGE-SCALE INVESTIGATIONS USING THE 40-BY 80-FOOT WIND TUNNEL AND THE V/STOL STATIC TEST FACILITY. THE INVESTIGATIONS ARE BEING CARRIED OUT TO PROVIDE BACKGROUND TECHNOLOGY FOR V/STOL AND STOL AIRCRAFT DESIGN AND TO DEVELOP ANALYTICAL METHODS OF PREDICTING AERODYNAMIC AND PROPULSIVE INTERACTION EFFECTS.

RTOP NO. 721-56-11 TITLE: LIFT-FAN AERODYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE BASIC RESEARCH OBJECTIVE IS TO DEVELOP THE TECHNOLOGY REQUIRED FOR IMPROVED PERFORMANCE AND STABILITY AND CONTROL OF POSSIBLE ADVANCED V/STOL LIFT-FAN AIRCRAFT CONFIGURATIONS THAT WOULD HAVE APPLICATION IN MILITARY AND CIVIL TRANSPORT AND IN MILITARY FIGHTER AND ATTACK MISSIONS. THE RESEARCH IS DIRECTED ALONG TWO LINES. THE MORE FUNDAMENTAL LINE IS TO PROVIDE A BASIC UNDERSTANDING OF THE AERODYNAMIC PHENOMENA INVOLVED AND TO DEVELOP THEORETICAL OR SEMI-EMPIRICAL MEANS OF PREDICTING THE AERODYNAMIC CHARACTERISTICS OF THE VEHICLES. THE OTHER LINE IS TO EXPLORE EXPERIMENTALLY THE AERODYNAMIC CHARACTERISTICS OF THE MORE NOVEL TYPES OF VEHICLES INVOLVED WITH A VIEW TOWARD DEFINING THEIR GROSS CHARACTERISTICS, THE PERTINENT VARIABLES, AND THE PROBLEM AREAS AND GENERAL METHODS OF SOLUTION. WIND-TUNNEL AND THEORETICAL STUDIES WILL BE USED TO IMPROVE THE CAPABILITY TO PREDICT THE AERODYNAMIC PERFORMANCE AND STABILITY AND CONTROL CHARACTERISTICS OF ADVANCED LIFT-FAN-POWERED VTOL AND STOL CONCEPTS AS THEY ARE PRESENTLY ENVISIONED, AND TO EXPLORE NEW AIRFRAME-PROPULSION INTEGRATION CONCEPTS AIMED AT

IMPROVEMENT IN PERFORMANCE.

RTOP NO. 721-56-12 TITLE: LIFT-FAN TRANSPORT, PROPULSION COMPONENTS
ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, L. TEL. 415-961-1111

TECHNICAL SUMMARY

STUDIES ARE BEING CARRIED OUT TO INVESTIGATE THE CHARACTERISTICS OF IMPROVED LIFT FANS. SOME OF THE STUDIES ARE ANALYTICAL AND ARE MADE BY CONTRACT AND DEAL WITH THE USE OF ADVANCED TECHNOLOGY TO IMPROVE LIFT-FAN PERFORMANCE, LIFT-FAN SIZE, AND LIFT-FAN WEIGHT. BASED ON SOME STUDIES MADE, TWO LIFT FANS OF 1.3 PRESSURE RATIO ARE BEING PROCURED AND WILL BE USED IN INVESTIGATIONS ON THE V/STOL STATIC TEST STAND AND IN THE 40- BY 80-FOOT WIND TUNNEL TO STUDY LIFT-FAN PERFORMANCE AS COMPARED WITH PREDICTED CHARACTERISTICS, AND TO STUDY LIFT-FAN AND AIRFRAME INTERACTION EFFECTS, PARTICULARLY IN THE CROSS-FLOW CONDITION THAT EXISTS IN TRANSITION FROM VTOL FLIGHT TO NORMAL HORIZONTAL FLIGHT. THE INTERACTION EFFECTS ARE IMPORTANT TO LIFT-FAN DESIGN AND LIFT-FAN INLET DESIGN.

RTOP NO. 721-56-14 TITLE: LIFT-FAN TRANSPORT NOISE REDUCTION
ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, L. TEL. 415-961-1111

TECHNICAL SUMMARY

THE 40- BY 80-FOOT WIND TUNNEL IS BEING EQUIPED TO PERMIT MEASUREMENTS TO BE MADE OF THE NOISE EMANATING FROM VARIOUS POWERED LIFT FAN CONFIGURATIONS DURING WIND TUNNEL TESTING. VARIOUS MODIFICATIONS ARE TO BE TESTED ON LIFT-FAN CONFIGURATIONS TO DETERMINE THEIR EFFECTIVENESS IN REDUCING THE NOISE LEVEL AND THEIR EFFECT ON THE AERODYNAMIC AND PROPULSIVE CHARACTERISTICS. AS A FOLLOW-ON TO A CONTRACTUAL STUDY, WHICH WAS CARRIED OUT TO INVESTIGATE TECHNIQUES TO REDUCE LIFT-FAN NOISE, A 1.3-PRESSURE-RATIO LIFT FAN IS BEING MODIFIED TO INCORPORATE NOISE REDUCTION FEATURE, AND INVESTIGATIONS WILL BE MADE TO MEASURE THE NOISE WITH AND WITHOUT NOISE REDUCTION FEATURES.

RTOP NO. 721-58-10 TITLE: EXTERNAL-FLOW JET-FLAP STOL RESEARCH
AIRCRAFT

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THE USE OF THE EXTERNAL-FLOW JET-FLAP CONCEPT AS A MEANS OF ACHIEVING STOL OPERATION IN TURBOFAN AIRCRAFT IS PRESENTLY OF GREAT INTEREST TO MILITARY AND COMMERCIAL AVIATION. EXTENSIVE WIND-TUNNEL STUDIES HAVE SHOWN THIS CONCEPT TO BE EFFECTIVE FOR PRODUCING THE HIGH LIFT NECESSARY FOR STOL OPERATION, BUT THERE IS A SERIOUS DEFICIENCY IN THE TECHNOLOGY FOR SUCH AN AIRCRAFT IN TERMS OF FLIGHT-TEST RESULTS OF A REALISTIC VEHICLE OPERATING UNDER REALISTIC TERMINAL AREA CONDITIONS. AN EXTERNAL-FLOW JET-FLAP STOL RESEARCH

AIRCRAFT FOR STUDYING, IN FLIGHT, THE PROMISING HIGH-LIFT CHARACTERISTICS INDICATED IN WIND-TUNNEL MODEL STUDIES AND ALSO PROVIDE A SUITABLE REPRESENTATIVE JET STOL AIRCRAFT FOR GENERAL OPERATIONAL RESEARCH WILL BE DEVELOPED IN A PROGRAM MANAGED BY THE FLIGHT RESEARCH CENTER. IN THE SUPPORT OF THIS PROGRAM, LANGLEY WILL BE RESPONSIBLE FOR THE AERODYNAMICS, PERFORMANCE, STABILITY AND CONTROL, AND HANDLING QUALITIES OF THE AIRCRAFT. LANGLEY WILL ALSO DEVELOP THE ADVANCED AVIONICS REQUIRED AND UTILIZE ONE OF THE AIRCRAFT IN INVESTIGATIONS OF IFR FLIGHT CHARACTERISTICS OF STOL AIRCRAFT IN THE TERMINAL AREA.

RTOP NO. 721-60-10 TITLE: AERODYNAMIC CHARACTERISTICS OF
PROPELLERS, ROTORS AND ROTORCRAFT
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

A JOINT NASA/ARMY PROGRAM IS DIRECTED TOWARD A "JET-FLAP" HELICOPTER ROTOR, IN WHICH A SHEET OF AIR IS BLOWN FROM THE TRAILING EDGE OF THE ROTOR BLADES, AND IN WHICH PITCH CONTROL IS OBTAINED THROUGH DEFLECTION OF THE "JET-FLAP". THE INVESTIGATION CONSISTS OF ANALYTICAL STUDIES AND STATIC AND WIND-TUNNEL TESTS. THIS METHOD OF PROPULSION AND CONTROL OFFERS THE POSSIBILITY OF REDUCED COMPLEXITY, HIGHER SPEEDS, AND LESS VIBRATION THAN WITH PRESENT TECHNOLOGY. THE PRACTICAL ASPECTS OF INCORPORATING THE "JET-FLAP" ROTOR INTO A COMPLETE VEHICLE ARE BEING INVESTIGATED. VARIOUS STOPPABLE ROTOR CONFIGURATIONS ARE BEING INVESTIGATED BY ANALYTICAL STUDIES AND IN THE WIND TUNNEL. THESE INCLUDE MEASUREMENTS OF ROTOR LOADS AND SHAFT MOMENTS AT VARIOUS COMBINATIONS OF ANGLE OF ATTACK AND ADVANCE RATIOS TO DETERMINE APPROPRIATE ROTOR CONTROL TECHNIQUES TO BE USED DURING THE ROTOR START-STOP PROCESS. THE WORK IS A COOPERATIVE EFFORT BY NASA AND THE ARMY. VARIOUS V/STOL AIRCRAFT PROPELLERS ARE BEING INVESTIGATED IN THE WIND TUNNEL, IN COOPERATION WITH AIR FORCE PROPELLER PROGRAMS, TO OBTAIN CHARACTERISTICS OF V/STOL AIRCRAFT PROPELLERS AND TO OBTAIN DATA FOR COMPARISON OF PROPELLER CHARACTERISTICS WITH PREDICTION BY ANALYTICAL METHODS. A JOINT NASA/ARMY PROGRAM HAS BEEN INITIATED TO STUDY THE EFFECT OF ADVANCED AIRFOIL SECTIONS ON PERFORMANCE. THIS PROGRAM WILL INCLUDE AIRFOIL STUDIES AND LARGE SCALE ROTOR TESTS.

RTOP NO. 721-60-10 TITLE: AERODYNAMIC CHARACTERISTICS OF PROPELLERS
AND ROTORS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

A CONTINUING RESEARCH EFFORT WILL BE MAINTAINED TO ASCERTAIN THE EFFECTIVENESS OF EXISTING THEORIES, EXTEND THE CAPABILITIES OF THEORETICAL METHODS, AND PROVIDE PROCEDURES FOR ANALYZING AND PREDICTING THE AERODYNAMIC AND PERFORMANCE CHARACTERISTICS OF ROTORS AND PROPELLERS. EXPERIMENTAL STUDIES WITH VARIOUS ADVANCED ROTOR AND PROPELLER CONCEPTS, INCLUDING SOME BASED ON NEW AIRFOIL TECHNOLOGY,

WILL BE UNDERTAKEN TO PROVIDE IMPROVED BASIC PERFORMANCE CHARACTERISTICS. ANALYSIS AND STUDY OF THE JET-FLAP ROTOR APPLICATIONS WILL BE MADE IN AN EFFORT TO BETTER UNDERSTAND AND OFFSET JET-DRIVE POWER LOSSES BY IMPROVED LIFT DISTRIBUTION AND WAKE INTERACTIONS. EXPERIMENTAL STUDIES WILL BE MADE OF VARIOUS PROMISING V/STOL AIRCRAFT CONFIGURATIONS, SUCH AS TILT PROP-ROTOR, UNLOADED ROTOR AND STOPPED ROTOR TYPES IN BOTH HOVERING AND HIGH SPEED FLIGHT REGIMES. PARTICULAR EMPHASIS WILL BE PLACED ON THOSE AREAS WHICH MAY PROVIDE IMPROVEMENTS IN HOVER AND HOT WEATHER PERFORMANCE, PROPELLER AND ROTOR NOISE, PARTICULARLY BLADE SLAP AND VIBRATORY AIRLOADS.

RTOP NO. 721-60-11 TITLE: ROTOR LOADS AND STRUCTURES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THIS WORK IS THE INVESTIGATION, DEFINITION, CONTROL, AND ALLEVIATION OF ROTOR SYSTEM VIBRATION, INSTABILITIES, AND OSCILLATORY STRESSES. THE CONCERN IS WITH ALL NONSTEADY PHENOMENON WHICH LIMIT THE UTILIZATION OF THE ROTOR SYSTEM.

THE BASIC PROBLEM STEMS FROM OPERATING A FLEXIBLE ROTOR SYSTEM IN A SELF-INDUCED TURBULENT ENVIRONMENT. THE PROBLEMS HAVE BEEN DEALT WITH IN THE PAST WITH LIMITED SUCCESS ON SPECIFIC CONFIGURATIONS. THE FUTURE PROMISES INCREASED DIFFICULTY WITH THE EVEN-INCREASING FORWARD SPEEDS THAT ARE BEING PROPOSED. THE PROBLEMS ASSOCIATED WITH A ROTOR FLYING IN ITS OWN WAKE HAVE PREVENTED THE UTILIZATION OF THE ROTORS FULL PERFORMANCE CAPABILITY. RESEARCH FOCUSED UPON THE BASIC PROBLEM OF ROTOR VIBRATION AND AEROELASTIC INSTABILITIES WILL HAVE APPLICATION TO ROTOR SYSTEM DESIGN CONCEPTS RANGING FROM THE PURE HELICOPTER TO COMPOUND, TILT-ROTOR, SLOWED ROTOR AND STOPPED ROTOR. THE APPROACH TAKEN IN THIS AREA OF RESEARCH IS TO FOCUS PRIMARY ATTENTION ON THE NON-STEADY AERODYNAMICS, SUCH AS WAKE INTERACTION, TIP-VORTEX FLOW, AND OSCILLATING AIRFOIL STUDIES. THE CRITICAL NEED IS IN THE AREA OF DEFINING THE AERODYNAMIC ENVIRONMENT OF THE ROTOR. A CLOSELY ASSOCIATED AREA OF WORK IS IN ROTOR SYSTEM AEROELASTIC STABILITY AND MECHANICAL STABILITY, WHICH DETERMINE THE SUCCESS OF A DESIGN IN REGARD TO SUCH THINGS AS FLUTTER, TORSIONAL DIVERGENCE, ROTOR WHIRL, AND GROUND/AIR RESONANCE. RESEARCH IS PLANNED IN THE AREAS OF ANALYTICAL STUDIES, WIND-TUNNEL TESTS OF MODEL AND LARGE SCALE ROTORS, TOWER TESTS, AND FLIGHT TESTS. BASIC AERODYNAMIC RESEARCH IS INCLUDED, SUCH AS BLADE TIP-VORTEX STUDIES TO FIND WHAT MIGHT BE DONE TO CONTROL AND ALLEVIATE A PRINCIPAL SOURCES OF ROTOR IMPULSIVE LOADINGS. ROTOR CONTROL SYSTEM MECHANICAL AND AEROELASTIC STABILITY STUDIES ARE PLANNED TO SOLVE THE PROBLEM OF CONTROL OF HIGH SPEED ROTOR SYSTEMS.

RTOP NO. 721-60-11 TITLE: ROTOR LOADS AND STRUCTURES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-1111
TECHNICAL SUMMARY

A NASA/ARMY/ONERA TILT-ROTOR PROGRAM IS UNDERWAY FOR

INVESTIGATION OF PERFORMANCE AND AEROELASTIC PREDICTION TECHNIQUES ON TILT-ROTOR DESIGN. BOEING-VERTOL IS THE CONTRACTOR (NAS2-5025) FOR THREE 13-FT-DIAMETER RIGID ROTORS, HAVING DIFFERENT TWIST DISTRIBUTIONS THAT HAVE BEEN INVESTIGATED AT SPEEDS UP TO 175 KNOTS IN THE AMES 40- BY 80-FOOT WIND TUNNEL AND ARE BEING INVESTIGATED IN THE ONERA MODANE 26-FT WIND TUNNEL AT SPEEDS FROM APPROXIMATELY 200 TO 500 KNOTS TO DETERMINE THE EFFECTS OF COMPRESSIBILITY ON CENTER-OF-PRESSURE MOVEMENT AND TORSIONAL DISTORTION NEAR THE ROTOR TIPS. FIVE-FT-DIAMETER ROTORS HAVE BEEN INVESTIGATED IN THE ARMY AERONAUTICAL RESEARCH LABORATORY 7- BY 10-FOOT WIND TUNNEL AT AMES TO DETERMINE THE EFFECTS OF SCALE AND REYNOLDS NUMBER ON ROTOR PERFORMANCE. TESTS OF A 25-FOOT DIAMETER TILT ROTOR IN THE 40 X 80-FOOT WIND TUNNEL WILL BE MADE TO STUDY ROTOR LOADS AND STABILITY. VARIOUS STOPPABLE ROTOR CONFIGURATIONS ARE BEING INVESTIGATED BY ANALYTICAL STUDIES AND IN THE WIND TUNNEL. THESE INCLUDE MEASUREMENTS OF ROTOR LOADS AND SHAFT MOMENTS AT VARIOUS COMBINATIONS OF ANGLE OF ATTACK AND ADVANCE RATIOS TO DETERMINE APPROPRIATE ROTOR CONTROL TECHNIQUES TO BE USED DURING THE ROTOR START-STOP PROCESS. A JOINT NASA/ARMY PROGRAM HAS BEEN INITIATED TO STUDY THE EFFECT OF ADVANCED AIRFOIL SECTIONS ON DYNAMIC LOADS. THESE MEASUREMENTS WILL BE MADE ON LARGE-SCALE ROTORS IN THE 40 X 80-FOOT WIND TUNNEL.

RTOP NO. 721-60-15 TITLE: ROTOR TEST VEHICLE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE BASIC OBJECTIVE IS TO DEVELOP AN ADVANCED ROTOR RESEARCH CAPABILITY, INCLUDING A FLIGHT VEHICLE, TO BE USED IN OBTAINING THE NECESSARY UNDERSTANDING AND DATA TO SUPPORT A MORE REALISTIC ROTOR AERODYNAMIC AND DYNAMIC ANALYSIS. THE LONG-TERM OBJECTIVE IS TO DEVELOP BETTER METHODS OF PREDICTING THE OPERATIONAL LIMITS OF ROTORCRAFT. THE TEST VEHICLE IS INTENDED TO HAVE (1) A PERFORMANCE CAPABILITY IN EXCESS OF PRESENT OPERATIONAL HELICOPTERS, (2) ADDITIONAL LIFT AND PROPULSIVE FORCE CAPABILITIES ABOVE THAT PROVIDED BY THE ROTOR, (3) A COMPUTERIZED FLIGHT CONTROL SYSTEM TO PROVIDE PREDETERMINED FLIGHT TEST CONDITIONS, AND (4) EXTENSIVE AND UNIQUE RESEARCH INSTRUMENTATION CAPABILITY. THE ROTOR TEST SYSTEM WILL BE DIRECTED AT GENERATING BASIC RESEARCH INFORMATION ON ROTOR AERODYNAMICS, NOISE, VIBRATION, STRUCTURAL DYNAMICS, AND FLIGHT DYNAMICS IN REGIONS OF THE OPERATIONAL ENVELOPE WHERE PRESENT INFORMATION IS INADEQUATE FOR USE IN PREDICTING LIMITATIONS OR INDICATES A POTENTIAL FOR IMPROVEMENTS IN THE OPERATIONAL ENVELOPE.

RTOP NO. 721-60-16 TITLE: TILT ROTOR RESEARCH AIRCRAFT
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-1111
TECHNICAL SUMMARY

THE PROGRAM IS DIRECTED TOWARD THE ADVANCEMENT OF TECHNOLOGY OF THE TILT-ROTOR AIRCRAFT CONCEPT TO THE POINT WHERE THE DESIGN OF COMMERCIAL OR MILITARY TRANSPORT EMPLOYING A TILT-ROTOR CAN BE

UNDERTAKEN WITH CONFIDENCE. THE PROGRAM WILL ENCOMPASS BOTH THE TILT-ROTOR AND THE TILT-FOLD-ROTOR CONCEPTS. WIND-TUNNEL TESTS WILL BE MADE OF LARGE-SCALE ROTORS AND OF SMALL-SCALE, FULL-SPAN, AND SEMISPAN MODELS. THE RESULTS OF THESE TESTS WILL AID IN THE DESIGN AND CONSTRUCTION OF AN EXPERIMENTAL TILT-ROTOR RESEARCH AIRCRAFT. THE TILT-ROTOR CONCEPT IS OF INTEREST TO BOTH COMMERCIAL AND MILITARY APPLICATIONS SINCE IT APPEARS TO OFFER A GOOD COMPROMISE BETWEEN SATISFACTORY HOVERING PERFORMANCE AND GOOD CRUISE EFFICIENCY. IT IS ALSO OF INTEREST FOR MILITARY TRANSPORT AND RESCUE MISSIONS BECAUSE OF THE LOW DOWNWASH VELOCITIES AND TEMPERATURES ASSOCIATED WITH LOW-DISC LOADING TILT ROTORS.

RTOP NO. 722-01-10 TITLE: AERODYNAMIC CHARACTERISTICS OF HYPERSONIC AIRCRAFT CONFIGURATIONS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, L. TEL. 415-961-1111

TECHNICAL SUMMARY

BECAUSE HYPERSONIC AIRCRAFT WILL ENCOUNTER NEW OR MAGNIFIED PROBLEMS, IN COMPARISON WITH LOWER SPEED AIRCRAFT IT IS ALREADY CERTAIN THAT THE SHAPE OF THESE VEHICLES WILL BE DIFFERENT. CONSEQUENTLY, AMES HAS UNDERTAKEN A BASIC RESEARCH INVESTIGATION TO DETERMINE, ANALYTICALLY AND EXPERIMENTALLY, FEASIBLE AND PRACTICABLE CONFIGURATIONS FOR HYPERSONIC AIRPLANES.

RTOP NO. 722-01-10 TITLE: HYPERSONIC RESEARCH AIRPLANE CONCEPT

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: GIBBONS, J. T. TEL. 805-258-3311

TECHNICAL SUMMARY

HYPERSONIC AIRCRAFT WITH AIRBREATHING PROPULSION SYSTEMS ARE POTENTIALLY ATTRACTIVE; HOWEVER, A FIRM HYPERSONIC AIRCRAFT TECHNOLOGICAL BASE MUST BE DEVELOPED PRIOR TO THE ACTUAL DESIGN AND DEVELOPMENT OF OPERATIONAL AIRCRAFT. A COMPREHENSIVE FLIGHT RESEARCH PROGRAM CAN AND SHOULD PLAY AN IMPORTANT ROLE IN DEVELOPING THIS REQUIRED TECHNOLOGY BASE. THE PRIMARY PURPOSE OF THE WORK PROPOSED HEREIN IS TO PROVIDE A CONTINUING ACTIVITY WHICH WILL PLACE THE FLIGHT RESEARCH CENTER IN A POSITION AT ALL TIMES TO TECHNICALLY SUPPORT THE DEFINITION, DEVELOPMENT, PROGRAM PLANNING, AND FLIGHT TEST OF ANY FUTURE HYPERSONIC RESEARCH AIRPLANE (HRA) PROGRAM. THIS TASK WILL INVOLVE: (A) STUDIES OF THE DEFICIENCIES IN HYPERSONIC AIRCRAFT TECHNOLOGY; (B) IDENTIFICATION OF SPECIFIC FLIGHT RESEARCH REQUIREMENTS; AND (C) THE ESTABLISHMENT OF GUIDELINES FOR CANDIDATE HRA CONCEPTS. ANALYTICAL STUDIES WILL BE PERFORMED IN-HOUSE TO DEFINE PRACTICAL HRA CONCEPTS AND ESTIMATES WILL BE MADE TO DEFINE TYPICAL HRA OPERATIONAL REQUIREMENTS, DEVELOPMENT SCHEDULES, PERFORMANCE, AND RESEARCH CAPABILITIES. CONTRACT STUDIES WILL BE USED TO PROVIDE SUFFICIENT DEPTH TO SPECIFIC AREAS RELATED TO THE DESIGN, DEVELOPMENT, AND QUALIFICATION OF HRA ENGINE AND AIRFRAME

HARDWARE.

RTOP NO. 722-01-10 TITLE: CONFIGURATION STUDIES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS TO PROVIDE THE TECHNOLOGY FOR THE DESIGN OF EFFICIENT, PRACTICAL HYPERSONIC AIRBREATHING AIRCRAFT. A NUMBER OF AIRCRAFT SYSTEMS ARE BEING STUDIED. THESE INCLUDE HYPERSONIC TRANSPORTS, MILITARY STRIKE AND RECONNAISSANCE VEHICLES, HYPERSONIC RESEARCH AIRPLANES, AND THE AIRBREATHING LAUNCH VEHICLE. THE AIRBREATHING LAUNCH VEHICLE WHICH IS CAPABLE OF PROVIDING A TRULY LOW-COST SPACE LOGISTICS SYSTEM CAN FILL AN EXPECTED NEED IN THE NASA/DOD PROGRAM IN THE 1985-1995 TIME PERIOD. IT WILL, THEREFORE, BE THE PRIMARY SYSTEM CONSIDERED. MOST OF THE TECHNOLOGICAL ADVANCES NEEDED FOR THIS SYSTEM WILL HAVE DIRECT APPLICATION TO OTHER HYPERSONIC AIRCRAFT. ANY AIRBREATHING LAUNCH VEHICLE SYSTEM INTENDED TO REPLACE THE ILRV DEVELOPED IN THE 1970'S, MUST FULLY EXPLOIT THE INTERACTIONS BETWEEN AERODYNAMICS, PROPULSION, STRUCTURES, TRAJECTORY SELECTION, ETC., TO ACHIEVE MAXIMUM OVERALL EFFICIENCY AND OPERATIONAL FLEXIBILITY. DETAILED WORK ON CONFIGURATION CONCEPTS, RELIABLE PREDICTION TECHNIQUES, FULL-SCALE REYNOLDS NUMBER EFFECTS, ENGINE-AIRFRAME INTEGRATION, ETC., WILL BE VIGOROUSLY PURSUED TO PROVIDE THE TECHNOLOGICAL BASE NECESSARY FOR DESIGNING AN AIRBREATHING LAUNCH SYSTEM TO MEET THESE REQUIREMENTS.

RTOP NO. 722-02-10 TITLE: STRUCTURES
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: VANO, A. E. TEL. 805-258-3311
TECHNICAL SUMMARY

THE PROGRAM WILL ATTEMPT TO EXPERIMENTALLY VALIDATE SIGNIFICANT HYPERSONIC-VEHICLE STRUCTURAL CONCEPTS AND INVESTIGATE FLIGHT-LOADS MEASURING TECHNIQUES FOR THESE STRUCTURAL CONCEPTS AS THEY APPLY TO THE MHTV.

RTOP NO. 722-02-10 TITLE: MATERIALS AND STRUCTURES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

RESEARCH AND DEVELOPMENT IS BEING CARRIED OUT TO ESTABLISH A TECHNOLOGY BASE FROM WHICH THE STRUCTURES FOR HYPERSONIC VEHICLES CAN BE DESIGNED AND EVALUATED. INCLUDED IN THE PROGRAM ARE BOTH ANALYTIC AND EXPERIMENTAL EFFORTS FOR THE DEVELOPMENT OF CONCEPTS FOR THERMAL PROTECTION OF LIQUID HYDROGEN TANKS, FUSELAGE STRUCTURES, WING STRUCTURES, AND PROPULSION STRUCTURES. RESEARCH DATA OBTAINED IN THE EXPERIMENTAL PROGRAM WILL SERVE TO EVALUATE DESIGN METHODS AND PROCEDURES AND TO ESTABLISH DESIGN APPLICATION GUIDELINES.

RTOP NO. 722-03-10 TITLE: INLETS AND INLET CONTROLS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-1111
TECHNICAL SUMMARY

FLIGHT AT HYPERSONIC SPEEDS WITH AIRBREATHING PROPULSION SYSTEMS WILL REQUIRE AIR INLETS OF LARGE SIZE AND A HIGH LEVEL OF PERFORMANCE. THE LARGEST SINGLE FACTOR AFFECTING INLET PERFORMANCE WILL BE THE CONDITION, OR STATE OF THE BOUNDARY LAYER ALONG THE INDUCTION PATH UNTIL THE ENGINE FACE IS REACHED. THEREFORE, AMES IS ENGAGED IN SEVERAL STUDIES TO GAIN GREATER INSIGHT INTO THE MECHANISM OF LAMINAR AND TURBULENT BOUNDARY LAYER GROWTH AT HYPERSONIC SPEEDS, AND THE INFLUENCE OF VARIOUS FACTORS KNOWN TO AFFECT THE BOUNDARY LAYER. THE PROBLEMS ARE BEING ATTACKED BY IN-HOUSE AND CONTRACT THEORETICAL STUDIES, AND WIND TUNNEL EXPERIMENTS.

RTOP NO. 722-03-10 TITLE: INLETS AND INLET CONTROLS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: LEZBERG, E. A. TEL. 216-433-4000
TECHNICAL SUMMARY

COMPONENT WORK ON HYPERSONIC INLETS WILL BE CONDUCTED WITH THE OBJECTIVE OF INVESTIGATING TWO AND THREE-DIMENSIONAL FIXED GEOMETRY CONCEPTS WITH EMPHASIS ON SIMULATING COMBUSTOR INLET INTERACTIONS AND DEVELOPING SIMULATION TECHNIQUES FOR PARTIAL INLET TESTING (TESTING IN THE LOCAL VEHICLE FLOW FIELD). HEAT SINK AND WATER COOLED MODELS WILL BE TESTED OVER THE MACH NUMBER RANGE OF 5-8 AT THE PLUM BROOK, HTF. PERFORMANCE RESULTS WILL BE COMPARED WITH EXISTING OR MODIFIED PREDICTION TECHNIQUES.

RTOP NO. 722-03-10 TITLE: PROPULSION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

BASIC RESEARCH AND INVESTIGATIONS TO DEVELOP AEROTHERMODYNAMIC CONCEPTS FOR THE SCRAMJET ENGINE FOR VEHICLE APPLICATIONS ARE UNDERWAY. AN ACTIVE INLET DESIGN AND TESTING PROGRAM IS IN PROGRESS FOR MACH NUMBERS UP TO 10. THESE INLETS RELY ON COMPLEX COMPRESSION SURFACES OR THREE-DIMENSIONAL CONTOURS TO ACHIEVE RAPID COMPRESSION, THUS SHORT HARDWARE, AND LOW SPILLAGE DRAG OVER A WIDE MACH NUMBER RANGE. IMPROVEMENTS ARE BEING MADE IN THE APPLICATION OF TRANSITIONAL BOUNDARY LAYER PARAMETERS AND OF REAL GAS CORRECTIONS TO THE BOUNDARY LAYER. AN INVESTIGATION OF THE EFFECT OF AERODYNAMIC AND GEOMETRIC PARAMETERS ON STARTING OF SIMPLE TWO-DIMENSIONAL HYPERSONIC INLET MODELS IS IN PROGRESS. THIS INVESTIGATION IS APPLICABLE TO THE DESIGN OF INLETS WHERE THE INTAKE FLOW CONTAINS A SIGNIFICANT AMOUNT OF BOUNDARY LAYER. INLETS FOR HYPERSONIC VEHICLES NECESSARILY WILL BE INTEGRATED WITH THE AIRFRAME AND WILL OFTEN BE LOCATED AFT WHERE BOUNDARY LAYERS ARE THICK. THE RESULTS OF THE ABOVE TECHNOLOGY PROGRAMS WILL BE FACTORED INTO THE OVERALL EFFORT TO DEVELOP ADVANCED SCRAMJET AEROTHERMAL CONCEPTS WITH LOW COOLING REQUIREMENTS.

RTOP NO. 722-03-11 TITLE: SUPERSONIC MIXING AND COMBUSTION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE SUPERSONIC MIXING AND COMBUSTION PROGRAM WILL BE AIMED PRIMARILY AT BASIC RESEARCH APPLYING TO ADVANCED AEROTHERMAL CONCEPTS FOR SCRAMJETS. ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS WILL BE ASSOCIATED WITH THE USE OF A COMBUSTION HEATER FOR SIMULATING CONDITIONS AT THE COMBUSTOR ENTRANCE CORRESPONDING TO FLIGHT MACH NUMBERS FROM 3 TO 9. INVESTIGATIONS OF COMBUSTION, FUEL INJECTION, MIXING, AND HEAT TRANSFER IN A VARIETY OF TWO DIMENSIONAL AND AXISYMMETRIC FLOW FIELDS FOR BOTH WALL AND STREAM INJECTION WILL BE CONDUCTED. A MAJOR PORTION OF THE WORK WILL BE FOCUSED ON COMBUSTOR CONFIGURATIONS FOR THREE-DIMENSIONAL SCRAMJET CONCEPTS DESIGNED FOR APPLICATION TO THE REUSABLE SHUTTLE BOOSTER; ASSOCIATED INLET TECHNOLOGY INVESTIGATIONS WILL BE DONE UNDER RTOP 722-03-10. SOME SPECIFIC TASKS IN THE PROGRAM WILL BE ACCOMPLISHED BY CONTRACT. IN ADDITION, PRELIMINARY RESEARCH ON METHODS TO OBTAIN TRUE SIMULATION IN GROUND FACILITIES UP TO THE MACH 9 TO 10 RANGE WILL BE CONDUCTED USING AN ARC HEATER IN COMBINATION WITH A BLOW DOWN TANK (HEAT), WHICH EFFECTIVELY INCREASES THE MASS FLOW AND PRESSURE CAPABILITY OF THE ARC HEATER.

RTOP NO. 722-03-11 TITLE: SUPERSONIC MIXING AND COMBUSTION
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-1111
TECHNICAL SUMMARY

STUDIES WILL BE INITIATED TO INVESTIGATE THE MUTUAL INTERACTION EFFECTS BETWEEN AN INLET AND A COMBUSTOR OPERATING AT HYPERSONIC MACH NUMBERS. THE MAJOR OBJECTIVES OF THE INVESTIGATION WILL BE TO DETERMINE THE PERFORMANCE CHARACTERISTICS OF A HYPERSONIC INLET IN THE PRESENCE OF A SUPERSONIC COMBUSTOR, INCLUDING THE SENSITIVITY OF COMBUSTOR PERFORMANCE TO INLET FLOW DISTORTION, AND UPSTREAM EFFECTS OF COMBUSTOR PRESSURE RISE ON INLET PERFORMANCE. EXPERIMENTAL STUDIES WILL BE CONDUCTED IN THE AMES 3.5-FOOT FACILITY USING A TWO-DIMENSIONAL INLET AND AN ATTACHED COLD FLOW SIMULATED COMBUSTOR. IN THESE TESTS NO BURNING WILL BE INITIATED BUT THE PRESSURE RISE WILL BE ARTIFICIALLY INDUCED. A SECOND SERIES OF TESTS WITH COMBUSTION WILL BE INITIATED IN THE AMES PILOT FACILITY UNDER FULLY SIMULATED INLET-COMBUSTOR CONDITIONS FOR FLIGHT MACH NUMBERS BETWEEN ABOUT 4.0 AND 7.0. ANALYSIS OF THE DATA WILL BE ACCOMPLISHED IN-HOUSE AND ON CONTRACT.

RTOP NO. 722-03-11 TITLE: SUPERSONIC MIXING AND COMBUSTION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: LEZBERG, E. A. TEL. 216-433-4000
TECHNICAL SUMMARY

COMBUSTION TECHNOLOGY WILL BE DEVELOPED BY: EXPERIMENTS IN SUPERSONIC PENETRATION AND MIXING FOR CONVENTIONAL FUEL INJECTOR DESIGNS AND FOR STRUT INJECTORS UTILIZING VORTEX EFFECTS; STUDIES OF

SUPERSONIC DIFFUSION FLAMES TO INVESTIGATE THE EFFECTS OF BURNING ON THE MIXING PROCESS; AND EXPERIMENTS ON THE IGNITION OF HYDROGEN IN THE TEMPERATURE REGION NEAR 1000 DEGREES K WITH VITIATED AIR. LARGE SCALE TESTS OF SUPERSONIC COMBUSTORS WILL BE CONDUCTED IN CLEAN AND VITIATED TEST STREAMS TO PROVIDE DESIGN INFORMATION FOR SUPERSONIC COMBUSTION ENGINES FOR VEHICLE APPLICATIONS. TESTS OF COMPLETE COMBUSTORS WITH STRUT AND WALL INJECTION WILL BE CONDUCTED AT PLUM BROOK, HTF, AT SIMULATED MACH 7 AND 8 FLIGHT CONDITIONS.

RTOP NO. 722-03-12 TITLE: EXHAUST NOZZLE SYSTEMS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: LEZBERG, E. A. TEL. 216-433-4000
TECHNICAL SUMMARY

ANALYTICAL AND EXPERIMENTAL STUDIES WILL BE CONDUCTED TO DEVELOP NOZZLES SUITABLE FOR INTEGRATION OF SUPERSONIC BURNING RAMJETS WITH A HYPERSONIC VEHICLE. MODULAR NOZZLE CONCEPTS WHICH PARTIALLY EXPAND THE FLOW FROM CYLINDRICAL OR RECTANGULAR COMBUSTORS AND TURN IT TOWARD THE VEHICLE REAR EXPANSION SURFACE WILL BE INVESTIGATED WITH THE OBJECTIVE OF DEVELOPING DESIGNS WHICH GIVE GOOD PERFORMANCE OVER A RANGE OF PRESSURE RATIOS CORRESPONDING TO THE FLIGHT MACH NUMBER RANGE REQUIRED FOR FUTURE VEHICLES. CONTRACTED STUDIES TO DEVELOP APPROPRIATE DESIGN TECHNIQUES, AND A SMALL SCALE EXPERIMENTAL PROGRAM WITH A DIRECT CONNECTED NOZZLE USING AN EXISTING ALUMINA PEBBLE BED AS A HOT AIR SOURCE WILL BE INITIATED. LARGE SCALE TESTS OF A NOZZLE IN CONNECTED PIPE TESTS WITH AN 18-INCH DIAMETER SUPERSONIC COMBUSTOR WILL FOLLOW IN THE PLUM BROOK HYPERSONIC TUNNEL FACILITY, AND PERFORMANCE RESULTS COMPARED WITH EARLIER RESULTS UTILIZING A SIMPLE CONICAL EXPANSION NOZZLE. FREE JET TESTS OF A PARTIAL INLET, COMBUSTOR, AND NOZZLE DESIGNS RESULTING FROM THE COMPONENT TESTS WILL THEN BE CONDUCTED AT SMALLER SCALE.

RTOP NO. 722-52-10 TITLE: HYPERSONIC RESEARCH ENGINE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

TO DEFINE A PRACTICAL, HIGH-PERFORMANCE, MACH 3 TO 8 LIQUID HYDROGEN HYPERSONIC RAMJET ENGINE OF LABORATORY SIZE BY BUILDING A FULL-SCALE, WATER-COOLED, AEROTHERMODYNAMIC INTEGRATION MODEL (AIM), AND A FULL-SCALE, HYDROGEN-COOLED, STRUCTURES ASSEMBLY MODEL (SAM) OF THE HRE; AND MEASURING THE AEROTHERMODYNAMIC PERFORMANCE FROM MACH 5 TO 7 WITH THE AIM AND EVALUATING AT MACH 7 THE ENGINE STRUCTURES THERMAL PERFORMANCE AND LOW CYCLE FATIGUE CHARACTERISTICS. THE OBJECTIVE IS TO ADVANCE AND CRYSTALLIZE THE TECHNOLOGY OF HYPERSONIC AIRBREATHING PROPULSION SYSTEMS AND EVALUATE THE REQUIREMENTS FOR FUTURE RESEARCH. THE SUPERIOR FUEL ECONOMY OF AIRBREATHING PROPULSION REQUIRES THAT SUCH SYSTEMS BE REEXAMINED IN LIGHT OF THE CURRENT TECHNOLOGY FOR APPLICATION TO ANY NEW HYPERSONIC ATMOSPHERIC FLIGHT MISSION.

RTOP NO. 727-01-01 TITLE: LIFTING BODY FLIGHT PROGRAM
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: MCTIGUE, J. G. TEL. 805-258-3311
TECHNICAL SUMMARY

THE LOW SUPERSONIC AND SUBSONIC CHARACTERISTICS OF LIFTING REENTRY VEHICLES ARE BEING STUDIED BY MEANS OF A COORDINATED FLIGHT AND WIND TUNNEL TEST PROGRAM WITH M2-F3, HL-10, AND X-24A AIRCRAFT. THE PROGRAM WILL YIELD THE DETAILED AERODYNAMIC CHARACTERISTICS OF THESE AIRCRAFT AND A MEASURE OF THE ABILITY OF THE WIND TUNNELS TO PREDICT THESE CHARACTERISTICS. IN ADDITION, OPERATIONAL CHARACTERISTICS IN THE TERMINAL AREA ARE BEING EXPLORED.

RTOP NO. 731-11-41 TITLE: HYDROGEN-OXYGEN LAUNCH VEHICLE ENGINE
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: DOUGLASS, H. W. TEL. 216-433-4000
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM HAS BEEN TO CONDUCT RESEARCH AND TECHNOLOGY DIRECTED AT REDUCING COSTS, IMPROVING RELIABILITY AND INCREASING THE OPERATIONAL CAPABILITY OF CRITICAL COMPONENTS OF HYDROGEN-OXYGEN LAUNCH VEHICLE ENGINES. HOWEVER, IN VIEW OF PRESSING DEMANDS FOR PERSONNEL IN OTHER AREAS, THIS ACTIVITY WILL BE PHASED OUT IN FY 1971.

RTOP NO. 731-11-43 TITLE: SHUTTLE AIRBREATHING ENGINE TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: STEWART, W. L. TEL. 216-433-6463
TECHNICAL SUMMARY

A CRITICAL ASPECT OF THE SHUTTLE MISSION, BASED UPON CURRENT REQUIREMENTS, IS THE LANDING PHASE FOR BOTH THE BOOSTER AND ORBITER VEHICLES. THIS PHASE OF THE MISSION WILL REQUIRE AIRBREATHING GAS TURBINE ENGINES EITHER OF THE JET OR FAN TYPE. THE EFFORTS TO BE MADE IN CONJUNCTION WITH THESE ENGINE PROGRAMS INCLUDE (A) THE STUDY OF CANDIDATE ENGINE FOR BOTH VEHICLES TO DETERMINE CHANGES IN STRUCTURE, MATERIALS, ETC. REQUIRED TO MEET THE NEW REQUIREMENTS IMPOSED BY THE SHUTTLE MISSION (LAUNCH, SPACE ENVIRONMENT, REENTRY, ETC.), (B) ASSOCIATED STUDIES OF PROBLEMS IN ADAPTING THESE ENGINES TO THE USE OF H₂ AS THE FUEL (COMBUSTOR MODIFICATIONS, ALTITUDE STARTING, ENGINE CONTROLS, PUMPING SYSTEMS, ETC.), (C) RELATED EXPERIMENTAL ACTIVITIES INCLUDING H₂ FEED SYSTEM, COMBUSTOR AND FUEL PUMPING INVESTIGATIONS, AS WELL AS ENVIRONMENTAL EFFECTS ON THE ENGINE, AND (D) UPON FINAL SELECTION OF THE ENGINES (OR ENGINE IF COMMONALITY CAN BE ESTABLISHED) THE MODIFICATION AND INVESTIGATION OF ONE OF EACH ENGINE AT A PACE SUCH THAT THEY MAY SERVE AS PRE-PROTOTYPE VERSIONS.

RTOP NO. 731-12-41 TITLE: PROPULSION SYSTEMS FOR PLANETARY APPLICATIONS

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: CONRAD, E. W. TEL. 216-433-4000

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE COMPONENT, SUBSYSTEM, AND SYSTEM DESIGN CRITERIA FOR PROPULSION SYSTEMS USING SPACE STORABLE AND HYDROGEN-FLUORINE PROPELLANTS AND TO DEMONSTRATE THE PERFORMANCE AND TECHNOLOGY READINESS OF BOTH A PUMP-FED STORABLE ENGINE AND COMPLETE PROPULSION MODULE, FOR SIMULATED MISSION OF 1200 DAYS. THE PROGRAM OBJECTIVES WILL BE MET THROUGH DESIGN, FABRICATION AND DEMONSTRATION TESTING OF A RESEARCH PROPULSION MODULE. APPLICABILITY TO A REAL FLIGHT SYSTEM WILL BE ENSURED BY THE USE OF FLIGHT WEIGHT HARDWARE AND BY CONSIDERATION OF ALL REAL AREAS OF SYSTEM INTERACTION, SPACE ENVIRONMENT, AND LAUNCH VEHICLE AND PAYLOAD CONSTRAINTS AND INTERFACES. THE PROGRAM WILL DEVELOP AND DEMONSTRATE TECHNOLOGY IN FOUR PRIMARY AREAS: (1) INVESTIGATION OF A 5000 POUND THRUST RESEARCH ENGINE USING FLOX-METHANE, (2) DEMONSTRATION OF TWO INTEGRATED PROPULSION MODULES SUITABLE FOR DEEP SPACE OPERATION (1200DAYS), (3) DEMONSTRATION OF A COMPLETE FLOX OR FLUORINE PROPELLANT FEED SYSTEM (INCLUDING PRESSURIZATION) WITH THE REQUIRED STEADY-STATE AND DYNAMIC OPERATING CHARACTERISTICS AND (4) INTEGRATION INTO THE PROPULSION MODULE OF ALL PRIMARY SUBSYSTEMS, SUCH AS AUXILIARY PROPULSION, ATTITUDE CONTROL SYSTEM, THRUST VECTOR CONTROL, ETC. ULTIMATELY, THE COMPLETE MISSION(S) WILL BE DEMONSTRATED IN THE B-2 FACILITY UNDER SIMULATED SPACE CONDITIONS. DIRECT TECHNOLOGY SUPPORT TO THE MODULE PROGRAM WILL BE PROVIDED BY IN-HOUSE AND CONTRACT PROGRAMS THAT ARE DIRECTED AT CRITICAL COMPONENT PROBLEMS.

RTOP NO. 731-12-42 TITLE: PRESSURE FED SPACE STORABLE PROPULSION MODULE

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MEEKS, P. TEL. 213-354-2546

TECHNICAL SUMMARY

THE WORK CONDUCTED UNDER THIS RTOP IS DIRECTED TOWARDS THE DEMONSTRATION OF THE PERFORMANCE AND OPERATIONAL CAPABILITIES OF A SPACE STORABLE PROPULSION MODULE USING OXYGEN DIFLUORIDE AND DIBORANE ($\text{OF}_2/\text{B}_2\text{H}_6$) AS PROPELLANTS UNDER ENVIRONMENTAL TEST CONDITIONS. BECAUSE OF ITS HIGH PERFORMANCE, THE PROPELLANT COMBINATION OF $\text{OF}_2/\text{B}_2\text{H}_6$ WILL SIGNIFICANTLY INCREASE SPACECRAFT PAYLOADS OVER CURRENTLY USED PROPELLANT COMBINATIONS. A PREPROTOTYPE DEMONSTRATION PROGRAM WILL BE PLANNED IN ORDER TO GAIN AN UNDERSTANDING AND REQUIRE A DEPTH OF KNOWLEDGE CONCERNING THE SUBSYSTEM INTERACTIONS OF A PROPULSION SYSTEM USING THE AFOREMENTIONED PROPELLANT COMBINATION. THE DEMONSTRATION SYSTEM WILL INITIALLY USE CURRENTLY AVAILABLE FLIGHT-WEIGHT (BUT SHORT DURATION) COMPONENTS. AS LONG-DURATION, FLIGHTWEIGHT COMPONENTS BECOME AVAILABLE THEY WILL BE SUBSTITUTED FOR THEIR LESS ADEQUATE COUNTERPARTS AND TESTS WILL BE CONDUCTED TO DETERMINE THE EFFECTS OF THE NEW COMPONENTS ON THE SYSTEM. THE PROGRAM WILL CONTINUE THIS APPROACH UNTIL THE METAMORPHOSIS BETWEEN THE PREPROTOTYPE SYSTEM AND THE FLIGHTWORTHY SYSTEM HAS BEEN

COMPLETED. THE LONG-DURATION, FLIGHTWEIGHT SYSTEM WILL THEN UNDERGO A MODIFIED PRE-FLIGHT RATING TEST SERIES TO VERIFY THE OPERATIONAL READINESS OF THE OF2/B2H6 PROPULSION MODULE FOR SPACECRAFT APPLICATION.

RTOP NO. 731-13-41 TITLE: AUXILIARY PROPULSION SYSTEMS

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: GREGORY, J. W. TEL. 216-433-4000

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE COMPONENT DESIGN CRITERIA, SYSTEM DESIGN CRITERIA AND SYSTEMS DEMONSTRATIONS FOR AUXILIARY PROPULSION SYSTEMS USING ADVANCED HIGH ENERGY CRYOGENIC AND SPACE STORABLE PROPELLANTS, SUCH AS HYDROGEN-FLUORINE AND FLOX-LIGHT HYDROCARBON FUELS. INITIALLY, EFFORTS WILL BE DEVOTED TO DEVELOPMENT OF COMPONENTS, INCLUDING INJECTORS, COOLED THRUST CHAMBERS, AND POSITIVE EXPULSION OR OTHER FEED DEVICES. IN F.Y. 1971, THE EFFORTS WILL BE DIRECTED TO COMPLETING THE COMPONENT WORK INITIATED IN PREVIOUS YEARS; NO NEW WORK WILL BE STARTED. EFFORTS IN SUCCEEDING YEARS WILL BE APPLIED TO SYSTEM DESIGN, CONTROLS, AND BUILD-UP OF COMPLETE BREADBOARD DEMONSTRATOR SYSTEMS TO EVALUATE SYSTEM INTERACTION AND CONTROL PROBLEMS. THE SYSTEMS WILL BE SIZED FOR POSSIBLE FUTURE INTEGRATION, EVALUATION, AND USE ON RESEARCH PROPULSION MODULES OR OTHER SIMULATED STAGES.

RTOP NO. 731-13-44 TITLE: AUXILIARY PROPULSION SYSTEMS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MEEKS, P. TEL. 213-354-2546

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS AREA OF WORK IS TO PROVIDE COMPONENTS, SYSTEM DESIGN AND DEMONSTRATION OF LOW THRUST CHEMICAL MANEUVERING AND ATTITUDE PROPULSION SYSTEMS WITH PARTICULAR ATTENTION TO LONG LIFE IN THE SPACE ENVIRONMENT. TO COMPLETE THE PRESENT ON-GOING ADVANCED DEVELOPMENT OF A LOW-THRUST SYSTEM USING MONOPROPELLANT HYDRAZINE FOR THE TOPS (THERMOELECTRIC OUTER PLANET SPACECRAFT) ATTITUDE PROPULSION. COMPONENTS INVESTIGATIONS WILL BE PERFORMED ON THE BASIS OF FAVORABLE COMPARISONS WITH EXISTING EXPERIMENTAL HARDWARE IN THE CASE OF NEW CONCEPTS, OR ON THE BASIS OF LOW OR UNRELIABLE PERFORMANCE IN THE DEMONSTRATION PROGRAM. ANALYSES AND COMPUTER PROGRAMS WHICH PREDICT HYDRAZINE REACTOR VACUUM START CHARACTERISTICS WILL BE COMPLETED AND WILL BE VERIFIED BY COMPARISON WITH EXPERIMENTAL TESTS. COMPATIBILITY OF CONSTRUCTION MATERIALS FOR LIQUID PROPULSION SYSTEMS WITH PROPELLANTS WILL BE TESTED AND THE IMPLICATIONS OF LONG-TERM SPACE STORAGE WILL BE INVESTIGATED. ADVANCEMENT OF THE STATE-OF-THE-ART OF EXPULSION DEVICES AND LIQUID PROPULSION SYSTEM COMPONENTS WILL BE PURSUED.

RTOP NO. 731-13-45 TITLE: MONOPROPELLANT AUXILIARY PROPULSION
SYSTEM DEMONSTRATION

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: YETMAN, A. A. TEL. 301-982-5021

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS AREA OF WORK IS TO EVALUATE LOW-THRUST CHEMICAL AUXILIARY PROPULSION SYSTEMS FOR APPLICATION TO SMALL SPACE VEHICLES. THE WORK WILL BE PRIMARILY RELATED TO MONOPROPELLANT HYDRAZINE SYSTEMS. THE EVALUATIONS CAN BE APPLIED TO THE DEVELOPMENT OF SYSTEMS DIRECTLY APPLICABLE TO PRESENT GSFC PROPULSION REQUIREMENTS FOR SPACECRAFT ATTITUDE CONTROL, STATION KEEPING, AND STATION CHANGING AND FOR LAUNCH VEHICLE VERNIER CORRECTION. THE MAJOR PORTION OF THIS WORK WILL BE CONDUCTED IN THE GSFC PROPULSION LABORATORIES AND AT THE GSFC CHEMICAL PROPULSION RESEARCH FACILITY.

RTOP NO. 731-13-48 TITLE: AUXILIARY PROPULSION ENGINES

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: NORED, D. L. TEL. 216-433-4000

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE THE REQUIRED BACKGROUND OF TECHNOLOGY FOR THE AUXILIARY PROPULSION ENGINES FOR THE SPACE SHUTTLE. THE MAJOR PORTION OF THIS WORK WILL BE DEVOTED TO ADVANCEMENTS IN THE ATTITUDE CONTROL THRUST CHAMBER ASSEMBLY AREA, INCLUDING THE INJECTOR, THRUST CHAMBER, IGNITION SYSTEM, AND VALVES. THE OPERATING CONDITIONS FOR THE EXPERIMENTAL WORK ON ATTITUDE CONTROL THRUSTERS WILL BE SELECTED TO FIT THE PARTICULAR REQUIREMENTS OF THE SPACE SHUTTLE. THIS WILL INCLUDE OPERATION WITH GASEOUS HYDROGEN/GASEOUS OXYGEN PROPELLANTS IN THE RANGE OF THRUST FROM 750-4000 POUNDS, CHAMBER PRESSURE FROM 20-500 PSIA, AND APPROPRIATE RANGES OF PROPELLANT INLET PRESSURES AND TEMPERATURES. PRIMARY EMPHASIS INITIALLY WILL BE ON THE INJECTOR-CHAMBER COOLING AREA. WHEN THE INDIVIDUAL COMPONENT TECHNOLOGY IS SUFFICIENTLY ADVANCED (BOTH WITHIN THIS RTOP AND THE COMPLEMENTARY RTOP 128-31-61, WHICH COVERS IGNITION AND VALVES), POINT DESIGN BREADBOARD THRUST CHAMBER ASSEMBLIES WILL BE FABRICATED AND ASSEMBLED TO PROVIDE AN EVALUATION OF OVERALL PERFORMANCE, RESPONSE AND DURABILITY. OTHER PROGRAMS RELATING TO THE SUPPLY, REGULATION, AND THERMAL CONDITIONING OF THE PROPELLANTS FED TO THE ATTITUDE CONTROL ENGINES ARE INCLUDED IN THIS RTOP. EFFORTS WILL ALSO BE INITIATED ON CHARACTERIZATION AND EVALUATION OF THE ORBITAL MANEUVERING SYSTEM (OMS) ENGINE.

RTOP NO. 731-13-48 TITLE: SPACE SHUTTLE VEHICLE AUXILIARY
PROPULSION SYSTEM

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: LOMBARDO, J. A. TEL. 205-453-3800

TECHNICAL SUMMARY

THE ESTABLISHMENT OF COMPONENT AND SYSTEM TECHNOLOGY REQUIRED FOR THE SPACE SHUTTLE AUXILIARY PROPULSION SYSTEM WILL BE ACHIEVED THROUGH THE VARIOUS TASKS OF THIS EFFORT. FIVE TASKS ARE IDENTIFIED WHICH WILL RESULT IN THE ESTABLISHMENT OF A SPACE SHUTTLE AUXILIARY

PROPULSION SYSTEM PRELIMINARY DESIGN, A PROPELLANT SUPPLY SYSTEM DESIGN INTEGRATING THOSE REQUIREMENTS OF SHUTTLE CRYOGEN USING SYSTEMS WHICH STUDIES SHOW SHOULD BE INTEGRATED, AND AN OPERATING BREADBOARD AUXILIARY PROPULSION SYSTEM. BOTH IN-HOUSE AND CONTRACTED EFFORTS ARE PLANNED WHICH INCLUDE ANALYSIS, DESIGN, FABRICATION, AND TEST PHASES.

RTOP NO. 731-13-49 TITLE: CHEMICAL ROCKET PLUME INTERACTIONS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: MARK, H. TEL. 216-433-4000
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO DETERMINE THE EFFECTS ON NEARBY SPACE VEHICLES AND VEHICLE COMPONENTS OF FIRING CHEMICAL ROCKET THRUSTERS FOR MANEUVERING ABOUT OR DOCKING TO THESE VEHICLES. SINCE THE EFFECTS OF CHEMICAL THRUSTER PLUME IMPINGEMENT MAY BE DELETERIOUS TO CONTINUED OPERATION OF SUCH EQUIPMENT, A COMPLETE STUDY OF THESE EFFECTS CANNOT, IN GENERAL, BE MADE IN FLIGHT. IT IS THE PURPOSE OF THE WORK DESCRIBED IN THIS RTOP TO MAKE THIS STUDY UNDER CORRECTLY SIMULATED CONDITIONS ON THE GROUND AND THUS TO DETERMINE THE LIMITS OF OPERATION FOR SUCH THRUSTERS DURING EXTRAVEHICULAR, DOCKING AND OTHER SIMILAR ACTIVITIES. INFORMATION WILL BE OBTAINED TO PERMIT OPTIMAL USE OF SUCH THRUSTERS IN PULSE MODE AS WELL AS FOR LONGER DURATION APPLICATION. AMINES AS MONOPROPELLANT AND BI-PROPELLANT, AS WELL AS HYDROGEN WILL BE INCLUDED AS FUELS. PROTECTIVE MEASURES WILL BE CONSIDERED FOR ENLARGING THE REGIME OF OPERATION OF SUCH THRUSTERS WITHOUT DAMAGE TO NEARBY VEHICLES OR CREW. CLEANING OF SURFACES OTHERWISE CONTAMINATED MAY BE POSSIBLE WITH HYDROGEN-OXYGEN ROCKET PLUME BLASTING AND THE POSSIBILITY OF SUCH A USE WILL BE EXAMINED FOR VARIOUS CONTAMINATED SURFACES.

RTOP NO. 731-13-50 TITLE: SPACE SHUTTLE AUXILIARY PROPULSION
EXPERIMENTAL ENGINEERING
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: POHL, E. P. TEL. 713-483-4924
TECHNICAL SUMMARY

TO FORM A SOUND SPACECRAFT PROPULSION SYSTEM TECHNOLOGY BASE FOR ADVANCED DESIGN AND TRADE-OFF STUDIES AND TO DETERMINE OPERATIONAL REQUIREMENTS OF THE EARTH-TO-ORBIT SHUTTLE SPACECRAFT, EXPERIMENTAL AND ANALYTICAL DATA WILL BE GENERATED FOR THE ATTITUDE CONTROL PROPULSION SYSTEM (ACPS) AND FOR THE ORBIT MANEUVERING PROPULSION SYSTEM (OMS). AN EXISTING "SPACE SHUTTLE AUXILIARY PROPULSION SYSTEM" PROGRAM WILL BE EXPANDED TO STUDY INTEGRATED SYSTEM CONCEPTS AND TO INITIATE TECHNOLOGY DEVELOPMENT FOR CRITICAL PROPELLANT FEED SYSTEM COMPONENTS SUCH AS TURBOPUMP GAS GENERATORS AND HEAT EXCHANGERS. COMPLEX ACPS COMPONENT AND FEED SYSTEM INTERACTIONS WILL BE STUDIED IN A BREADBOARD TEST PROGRAM TO DETERMINE DISTRIBUTION, ENGINE TRANSIENT EFFECTS, AND INTERFACE REQUIREMENTS FOR THE LOW PRESSURE SYSTEM. AN OPTIMUM OMS WILL BE DESIGNED IN A PRELIMINARY TRADE-OFF STUDY EFFORT TO DETERMINE SYSTEM OPERATING REQUIREMENTS AND

DESIGN PARAMETERS AND IDENTIFY THE TECHNOLOGY AREAS WHICH WILL REQUIRE IMPROVEMENT. THE PRELIMINARY OMS DESIGN WILL BE USED AS A BASE TO EVALUATE USE OF EXISTING OR MODIFIED ENGINE SYSTEMS (SUCH AS THE RL10) AND TO STUDY USE OF THE ACPS TO PERFORM THE MAJOR ORBITAL MANEUVERS.

RTOP NO. 731-14-10 TITLE: ATMOSPHERIC DIFFUSION OF TOXIC PROPELLANT BY-PRODUCTS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

THE LONG RANGE OBJECTIVES OF THIS EFFORT ARE: TO IMPLEMENT ATMOSPHERIC DIFFUSION MODELS MADE AVAILABLE UNDER CONTRACTS NAS8-30503 AND NAS8-24438, WHICH ARE TO PREDICT DOWNWIND CONCENTRATION OF TOXIC TYPE VEHICLE EXHAUST BY-PRODUCTS DURING LAUNCH ACTIVITIES AS ASSOCIATED WITH SKYLAB AND SPACE SHUTTLE TYPE VEHICLES, AND DETERMINE ATMOSPHERIC DATA INPUT TO MODELS; AND MAKE ANY NECESSARY MODIFICATIONS, AND VERIFY THE DIFFUSION PREDICTION MODELS. THE ATMOSPHERIC DIFFUSION MODELS APPLICABLE TO THE KSC ENVIRONMENT WILL BE IMPLEMENTED IN FY-71. A CONTRACTOR, WITH A FLUENT UNDERSTANDING OF ATMOSPHERIC DIFFUSION THEORY AND AUTOMATIC COMPUTER SYSTEMS, WILL IMPLEMENT THE DIFFUSION MODELS. THESE MODELS APPLY TO CONTAMINATES RELEASED INTO THE ATMOSPHERE AT ANY POINT FROM SURFACE TO 30KM. DIFFUSION MODELS WILL PREDICT DOWNWIND ESTIMATES OF PARTICULATE AND GASEOUS MATERIALS. MODELS WERE TAILORED TO KSC ENVIRONMENT IN THAT MUCH OF NASA'S 150-METER METEOROLOGICAL TOWER DATA AND UPPER ATMOSPHERIC DATA FOR KSC WERE USED TO DEVELOP NECESSARY PARAMETRIC INPUT DATA.

RTOP NO. 731-25-51 TITLE: LAUNCH VEHICLE SOLID MOTORS

ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: CIEPLUCH, C. C. TEL. 216-433-6167

TECHNICAL SUMMARY

THIS PROGRAM ENCOMPASSES THE DEVELOPMENT OF TECHNOLOGY FOR LOW COST AND IMPROVED RELIABILITY IN FUTURE LARGE SOLID MOTOR BOOSTED LAUNCH VEHICLES. THE SEVERE REDUCTION IN PROGRAM FUNDS FOR FY 1970 PREVENTED THE ACCOMPLISHMENT OF THE PROGRAM OUTLINED IN THE FY 1970 RTOP. WITH NO FUNDING AVAILABLE FOR FY 1971, NO NEW EFFORTS WILL BE INITIATED; THE TECHNOLOGY CONTRACTS INITIATED IN PREVIOUS YEARS WILL BE COMPLETED. THOSE TECHNOLOGY PROGRAMS THAT WILL CARRY OVER INTO FY 1971 INCLUDE WORK ON LOW COST AND RELIABLE MATERIALS FOR MOTOR CASES, CASE INSULATION AND NOZZLE ABLATIVES. WORK WILL ALSO CONTINUE IN THE PROPELLANT AREA, TO IDENTIFY AND EVALUATE LOW COST INGREDIENTS AND TO IMPROVE NONDESTRUCTIVE TEST TECHNIQUES. IN ADDITION, AN IN-HOUSE STUDY EFFORT WILL BE UNDERTAKEN TO INCORPORATE TECHNOLOGIES RECENTLY DEVELOPED FOR REDUCING MOTOR COST AND/OR IMPROVING RELIABILITY INTO AN ADVANCED MOTOR DESIGN, TO ESTABLISH AN OPTIMUM CONFIGURATION FOR POTENTIAL SHUTTLE APPLICATIONS AND TO DETERMINE OVERALL COST IMPROVEMENTS.

RTOP NO. 731-25-55 TITLE: SOUNDING ROCKET PROPULSION TECHNOLOGY
DEVELOPMENT

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: DRALEY, E. C. TEL. 703-827-3285

TECHNICAL SUMMARY

CURRENT USAGE PREDICTIONS INDICATE THAT FOR MANY YEARS TO FOLLOW LARGE NUMBERS (3000 OR MORE PER YEAR) OF SOUNDING ROCKETS WILL BE REQUIRED FOR BOOSTING METEOROLOGICAL AND SMALL SCIENTIFIC PAYLOADS TO ALTITUDES IN THE 20-70 KILOMETER RANGE. CONSIDERABLE SAVINGS CAN BE REALIZED THROUGH THE SUBSTANTIAL REDUCTION OF THE UNIT COST BY UTILIZING MOLDING TECHNIQUES, SIMPLIFIED PROCESSING TECHNIQUES, AND APPROACHES DESIGNED TO REDUCE PRODUCTION AND QUALITY CONTROL MANPOWER REQUIREMENTS FOR THE ROCKET MOTORS. IN ADDITION, REQUIREMENTS FOR CERTAIN ASTRONOMY AND SOLAR PHYSICS EXPERIMENTS DICTATE A NEED FOR LARGER PAYLOADS AT CONSIDERABLY HIGH ALTITUDES. THESE EXPERIMENTS CAN BE MORE EASILY CONDUCTED WHEN IMPROVED BOOSTERS COMPATIBLE WITH THE PAYLOADS ARE DEVELOPED. THE PRIMARY AREAS REQUIRING ATTENTION ARE IMPROVEMENTS IN THE PERFORMANCE CAPABILITIES, EXTENSION OF ENVIRONMENTAL AND OPERATIONAL LIMITS, AND REDUCTION OF THE SYSTEM COST. THE OBJECTIVE OF THIS PROGRAM IS TO DEVELOP AND DEMONSTRATE THROUGH APPROPRIATE TESTING THE TECHNOLOGIES NECESSARY TO MEET THESE COST AND PERFORMANCE REQUIREMENTS FOR SOUNDING ROCKET BOOSTERS.

RTOP NO. 731-26-52 TITLE: HYBRID PROPULSION ENGINEERING

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: DRALEY, E. C. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO ESTABLISH ALL THE REQUIRED ELEMENTS OF TECHNOLOGY FOR HIGH ENERGY HYBRID PROPULSION SYSTEMS SO THAT FUTURE MOTOR DEVELOPMENT AND QUALIFICATION PROGRAMS CAN BE INITIATED WITH HIGH CONFIDENCE THAT TECHNICAL, COST, AND SCHEDULE GOALS CAN BE MET WITHOUT SERIOUS OBSTACLES. CONTRACTED EFFORTS SINCE 1964 HAVE DEMONSTRATED THE TECHNICAL FEASIBILITY AND HIGH POTENTIAL OF HIGH ENERGY HYBRID PROPULSION SYSTEMS FOR UPPER STAGE APPLICATIONS. STUDIES INDICATE THAT THE HYBRID ROCKET WILL PERFORM AS WELL AS COMPETITIVE "SPACE STORABLE" LIQUID SYSTEMS NOW UNDER INVESTIGATION AND THAT THE HYBRID CAN BE DEVELOPED AT A SIGNIFICANTLY LOWER COST. THE CONTRACTED DEMONSTRATION OF HYBRID PROPULSION TECHNOLOGY AT THE PROTOTYPE LEVEL IS NOW UNDERWAY AT THE UNITED TECHNOLOGY CENTER, SUNNYVALE, CALIFORNIA. THE CURRENT PROGRAM IS THE INITIAL PHASE OF A PREVIOUSLY ANTICIPATED THREE-PHASE (5-YEAR) EFFORT WHICH WOULD HAVE YIELDED A PROTOTYPE HYBRID ROCKET STAGE COMPLETE WITH FLIGHT-WEIGHT COMPONENTS, BOTH FOR THE OXIDIZER AND FUEL SYSTEMS. FUNDING LIMITATIONS HAVE NECESSITATED A MAJOR RESTRUCTURING OF THE PROPOSED EFFORT. THE DEMONSTRATION PROGRAM HEREIN PROPOSED WOULD CONTINUE HYBRID TECHNOLOGY DEVELOPMENT AT A GREATLY REDUCED LEVEL AND SCOPE. ALL DEMONSTRATIONS WILL BE IN HEAVYWEIGHT REUSABLE HARDWARE. NO EFFORT WILL BE CONDUCTED ON THE LIQUID (OXIDIZER) SYSTEM AS THIS TECHNOLOGY IS BEING PURSUED IN COMPETITIVE LIQUID BI-PROPELLANT SYSTEM DEMONSTRATIONS. THIS SCALED-DOWN PROGRAM WILL PROVIDE SEVERAL ADDITIONAL FIRINGS OF THE ADVANCED HIGH-LITHIUM FUEL AT SEA LEVEL CONDITIONS IN THE 3200-POUND PROPELLANT SIZE WITH

SUBSEQUENT EVALUATION UNDER SIMULATED ALTITUDE CONDITIONS. A LIMITED STUDY WILL BE CONDUCTED TO SIZE A HYBRID STAGE ATOP A TITAN-CENTAUR VEHICLE FOR SELECTED MISSIONS. THIS LARGER SIZE HYBRID WILL THEN BE DEMONSTRATED IN HEAVYWEIGHT HARDWARE AT BOTH SEA LEVEL AND SIMULATED ALTITUDE CONDITIONS.

RTOP NO. 731-26-53 TITLE: SOLID HIGH ENERGY SPACE MOTOR
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. TEL. 213-354-2546
TECHNICAL SUMMARY

THE OBJECTIVE IS TO ESTABLISH BY FY 1973 THE TECHNOLOGIES AND FUNCTIONS OF A PROTOTYPE SOLID PROPELLANT SPACE PROPULSION SYSTEM WITH THE FOLLOWING CHARACTERISTICS: DELIVERED SPECIFIC IMPULSE OF 327 TO 330 SECONDS AT SPACE CONDITIONS, STOP AND RESTART CAPABILITY, ABOUT 885,000 POUND-SECONDS IMPULSE, AND THRUST OF APPROXIMATELY 15,000 POUNDS. THE APPROACH IS TO MAKE NECESSARY PROPELLANT BURNING AND QUALIFICATION TESTS. TEST IN SUBSCALE THE MATERIALS AND FUNCTIONS OF QUENCH SYSTEM. ESTABLISH QUENCH PATTERN, QUENCH DESIGN AND MATERIAL. ESTABLISH BEST STOP-RESTART CYCLE; DESIGN COMPLETE QUENCH SUBSYSTEM. DESIGN, TEST, EVALUATE A TEST WEIGHT DESIGN, AND THE EFFECTS OF SLAG ACCUMULATION AND CONCENTRATED HEATING. ASSEMBLE AND EVALUATE EQUIPMENT TO CONTAIN BERYLLIUM EXHAUST PRODUCTS FROM STATIC FIRINGS. EVALUATE A PROTOTYPE DESIGN AT SPACE CONDITIONS WITH AN ELECTED STOP-RESTART CYCLE. THE UTILIZATION OF THIS MOTOR FOR FUTURE MISSIONS CAN BE COST EFFECTIVE IN COMPARISON TO UTILIZATION OF A LARGER BOOSTER.

RTOP NO. 731-26-54 TITLE: SOLID SPACE PROPULSION
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. TEL. 213-354-2546
TECHNICAL SUMMARY

ESTABLISH THE TECHNOLOGY FOR ADVANCED SOLID SPACE PROPULSION SYSTEM WHICH CAN MEET THE REQUIREMENTS FOR PLANETARY ORBITER SPACECRAFT. THE MAJOR REQUIREMENT IS FOR A LOW-THRUST LONG-BURNING-TIME HIGH PERFORMANCE PROPULSION SYSTEM. THE CONCEPT UNDERSTUDY IS THE FULLY-CASE-BONDED END-BURNING GRAIN CONFIGURATION WHICH PRODUCES ACCELERATION LEVELS OF LESS THAN 0.5 G. THE FEASIBILITY OF THE CONCEPT HAS BEEN DEMONSTRATED AT JPL IN FY'69. THE FY'71 EFFORT WILL BE LIMITED TO CONTINUATION OF THIS IN-HOUSE WORK TO IMPROVE THE END BURNER PERFORMANCE, TO INVESTIGATE THE EFFECT OF CHANGES IN CONFIGURATION ON PERFORMANCE, AND TO EXPLOIT APPLICATION OF THE END-BURNER----

RTOP NO. 731-28-10 TITLE: SOLID TEST METHODS, INSTRUMENTATION AND
SUPPORT

ORGANIZATION: NASA HEADQUARTERS

MONITOR: COHEN, W.

TEL. 202-962-1807

TECHNICAL SUMMARY

THE OBJECTIVE IS TO OBTAIN FISCAL AND TECHNICAL INFORMATION NEEDED FOR LONG-RANGE PLANNING OF SOLID PROPULSION PROGRAM; TO ENHANCE THE SAFETY OF MANUFACTURE AND USE OF SOLID MOTORS; TO SUPPORT INTERGOVERNMENT AGENCIES FOR INFORMATION EXCHANGE. STUDY CONTRACTS OR ASSIGNMENTS ARE ESTABLISHED TO ANALYZE FUTURE PROPULSION REQUIREMENTS AND TO DEFINE MISSIONS IN WHICH FUTURE SOLID (AND HYBRID) SYSTEMS CAN BE USED. COST ANALYSIS IS MADE TO REEVALUATE AND JUSTIFY TECHNOLOGY PROGRAMS LEADING TO THE SYSTEMS FOR MISSION AREAS. WORK IS SUPPORTED ON HAZARD ANALYSIS AND ON TECHNIQUES TO MINIMIZE HAZARDS OF SOLID PROPULSION SYSTEMS. FUNDS ARE PROVIDED TO CPIA, AN INTERAGENCY INFORMATION CENTER ON CHEMICAL PROPULSION.

RTOP NO. 735-40-01 TITLE: ORBITING FROG OTOLITH PROGRAM

ORGANIZATION: WALLOPS STATION

MONITOR: ROSSI, L. C.

TEL. 703-824-3411

TECHNICAL SUMMARY

THE ORBITING FROG OTOLITH PROJECT EXPERIMENT WILL RECORD DIRECTLY THE CHANGES IN ACTIVITY OF THE OTOLITH SYSTEM WHICH MIGHT OCCUR DURING A PERIOD OF PROLONGED WEIGHTLESSNESS. THIS ENVIRONMENTAL CHANGE IS PARTICULARLY SIGNIFICANT BECAUSE THE GRAVITORECEPTORS OF THE VESTIBULAR APPARATUS, THE OTOLITH, ARE SUBJECTED TO A UNIQUE SITUATION IN RESPECT TO THE OTHER SENSE ORGANS. THEIR DEVELOPMENT TAKES PLACE UNDER A CONSTANT LG STIMULATION WHICH IS PRESENT BEFORE THEY DIFFERENTIATE AND WHICH IS MAINTAINED UP TO THE PRESENT TIME THROUGHOUT THE LIFE SPAN. JET FLIGHT, SPACE FLIGHT, AND POSSIBLE FUTURE MISSIONS ON PLANETS WITH DIFFERENT GRAVITATIONAL CONSTANTS HAVE SUDDENLY CHANGED THIS SITUATION. EXPERIMENT SCIENTISTS WILL BE ABLE TO STUDY FOR THE FIRST TIME HOW THE OTOLITH SENSORS, LONG ADAPTED TO ENVIRONMENTAL STIMULUS, BOTH IN THE INDIVIDUAL AND IN THE SPECIES AS A WHOLE, REACT TO A RADICAL CHANGE TO A LONG ESTABLISHED HABITUATION INVOLVING THEIR SPECIFIC FUNCTION. THIS WILL BE ACCOMPLISHED BY IMPLANTING MICROELECTRODES IN THE VESTIBULAR NERVES OF TWO BULLFROGS----

RTOP NO. 736-05-10 TITLE: GENERAL AVIATION FLIGHT DYNAMICS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, L.

TEL. 415-961-1111

TECHNICAL SUMMARY

A FLIGHT INVESTIGATION IS UNDERWAY TO DETERMINE THE FLIGHT

CHARACTERISTICS OF AN EXECUTIVE JET AIRCRAFT REPRESENTATIVE OF THOSE JET AIRCRAFT IN THE GENERAL AVIATION FLEET. THE NASA 701 LEAR JET HAS BEEN INSTRUMENTED TO PROVIDE DOCUMENTATION OF BOTH STATIC AND DYNAMIC FLIGHT CHARACTERISTICS. SPECIAL ATTENTION WILL BE DIRECTED TO DETERMINE THE EFFECTS OF TURBULENCE ON THE HANDLING QUALITIES FOR ALL NORMAL FLIGHT REGIMES. ADVANCED FLIGHT DISPLAYS WILL BE STUDIED AS A POTENTIAL FOR SIGNIFICANT REDUCTIONS IN PILOT WORKLOAD. CURRENT, IN-HOUSE STUDIES ARE BEING MADE OF EFFECTS OF TURBULENCE ON THE HANDLING QUALITIES AND PASSENGER RIDE QUALITIES OF REPRESENTATIVE GENERAL AVIATION COMMUTER (THIRD LEVEL CARRIER) AIRCRAFT, COVERING A WIDE RANGE OF AIRCRAFT RESPONSE TO TURBULENCE (E.G., LARGE VARIATIONS IN WING LOADING). A CONTRACT HAS BEEN AWARDED TO AERONAUTICAL RESEARCH ASSOCIATES OF PRINCETON (NAS2-5589) FOR A FLIGHT INVESTIGATION OF SPOILER/DIVE BRAKES INSTALLED IN A LIGHT AIRCRAFT TO DETERMINE POTENTIAL IMPROVEMENTS IN GLIDE PATH CONTROL, AND FLARE-TOUCH-DOWN MANEUVERS, AND AS A SAFETY DEVICE TO BE USED IN OVERSPEED CONDITIONS.

RTOP NO. 736-10-10 TITLE: PILOT-WARNING INDICATOR SYSTEMS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: WINBLADE, R. L. TEL. 202-962-4601
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP AN INEXPENSIVE, RELIABLE P.W.I. SYSTEM APPLICABLE TO GENERAL AVIATION AIRCRAFT OPERATING UNDER VFR FLIGHT CONDITIONS. THIS WORK WILL CONTINUE THE EXPERIMENTAL FLIGHT TESTING AND EVALUATION OF OPTICAL P.W.I. SYSTEMS.

RTOP NO. 737-01-10 TITLE: CONFIGURATION STUDIES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

TO DETERMINE THE POSSIBLE IMPROVEMENTS IN AERODYNAMIC CHARACTERISTICS, FLYING QUALITIES, AND PERFORMANCE APPLICABLE TO ADVANCED SUBSONIC COMMERCIAL TRANSPORT AIRCRAFT. PARTICULAR ATTENTION WILL BE DIRECTED TO THE COMBINATIONS OF DESIGN FEATURES FOR IMPROVING THE OVERALL LIFT-DRAG RATIO INCLUDING EFFECTS OF ASPECT RATIO, CAMBER, AND TWIST, AS WELL AS THE USE OF FENCES, PYLONS, AND NACELLES IN FAVORABLE ARRANGEMENTS. ALSO TECHNIQUES FOR EXTRAPOLATION OF WIND-TUNNEL TEST DATA TO FULL-SCALE ARE BEING INVESTIGATED.

RTOP NO. 737-08-10 TITLE: OPTIMUM DESIGN OF SUBSONIC AIRCRAFT
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THIS PROGRAM WILL ESTABLISH THE EXTENT OF AERODYNAMIC IMPROVEMENTS MADE POSSIBLE BY THE USE OF AUTOMATIC CONTROL DEVICES ON VARIOUS TYPES OF AIRPLANES. DEVELOPMENT OF ANALYTICAL AND EXPERIMENTAL TECHNIQUES IS PROPOSED WHICH WILL ALLOW THE SUBSTITUTION OF INHERENT STABILITY CHARACTERISTICS BY AUTOMATIC FEEDBACK CONTROL. THE PRESENT STATE OF RELIABILITY OF AUTOMATIC CONTROL DEVICES ENABLES THEM TO BE CONSIDERED FOR SUCH A ROLE.

RTOP NO. 737-51-10 TITLE: TURBOFAN NACELLE MODIFICATIONS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

PROBLEM - TO DEVELOP ACOUSTIC TREATMENT DESIGNS FOR REDUCING THE TURBINE NOISE AND TURBULENCE GENERATED NOISE RADIATED FROM A JET ENGINE TAILPIPE. APPLICATION - ALTHOUGH THE ACOUSTIC TREATMENT WILL BE TAILORED TO A SPECIFIC ENGINE, THE DESIGN CRITERIA WILL BE PRESENTED IN GENERAL TERMS SO THAT IT CAN BE APPLIED TO CURRENT AND FUTURE TECHNOLOGY COMMERCIAL FANJET ENGINES. APPROACH - CONTRACT FOR THE DESIGN AND DEVELOPMENT OF AN ACOUSTICALLY TREATED TAILPIPE FOR GROUND TESTS ON A JT3D ENGINE. CONDUCT NOISE MEASUREMENTS AND ENGINE PERFORMANCE ANALYSIS.

RTOP NO. 737-52-10 TITLE: EXPERIMENTAL QUIET ENGINE
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: KRAMER, J. J. TEL. 216-433-4000
TECHNICAL SUMMARY

PRELIMINARY DESIGN STUDIES AND LEWIS IN-HOUSE RESEARCH HAVE INDICATED THAT A SUBSTANTIAL REDUCTION IN NOISE OUTPUT OF ENGINES SUITABLE FOR SUBSONIC TRANSPORT AIRCRAFT CAN BE ACHIEVED. THE NEXT STEP IN THIS PROGRAM IS TO DEMONSTRATE THIS TECHNOLOGY IN AN EXPERIMENTAL ENGINE. CONTRACT PROGRAMS WILL PROVIDE ENGINE DETAILED DESIGNS AND FABRICATION, TESTING AND DELIVERY OF TEST ENGINES TO LEWIS RESEARCH CENTER. SUBSEQUENT TESTS OF THESE ENGINES AT LEWIS WITH ACOUSTICALLY TREATED NACELLES WILL DEMONSTRATE MINIMUM INSTALLED PROPULSION SYSTEM NOISE LEVELS.

RTOP NO. 737-52-11 TITLE: QUIET ENGINE RESEARCH
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: KRAMER, J. J. TEL. 216-433-4000
TECHNICAL SUMMARY

RESEARCH WILL BE PERFORMED IN VARIOUS AREAS IN DIRECT SUPPORT OF THE QUIET ENGINE. PRIME AREAS OF ACTIVITY ARE FULL-SCALE FAN NOISE TESTING AND FULL-SCALE SUPPRESSOR DEVELOPMENT. THE WORK IN THIS PROGRAM IS IN DIRECT SUPPORT OF RTOP 737-52-10 (EXPERIMENTAL QUIET

ENGINE). IN THIS PROGRAM VARIOUS PROBLEM AREAS WILL BE EXPLORED USING HARDWARE OF APPROPRIATE SCALE FOR USE IN THE QUIET ENGINE. INITIAL ACTIVITY WILL CONSIST OF TESTING FULL-SCALE FANS AND SUPPRESSORS DESIGNED FOR USE IN THE QUIET ENGINE. SUBSEQUENT POTENTIAL WORK AREAS ARE SUPPRESSORS FOR FURTHER NOISE REDUCTION OF LOW-VELOCITY JET EXHAUSTS AND INLET CHOKING DEVICES TO REDUCE FAN INLET RADIATED NOISE.

RTOP NO. 737-54-10 TITLE: SUPERCRITICAL WING
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

TO DETERMINE THE FEASIBILITY OF APPLYING THE SUPERCRITICAL WING CONCEPT TO AIRPLANE CONFIGURATIONS. PARTICULAR ATTENTION WILL BE DIRECTED TO THE INTEGRATION OF THE WING WITH THE FUSELAGE, THE APPLICATION OF AERODYNAMIC CONTROL SURFACES, THE DEVELOPMENT OF LOW SPEED HIGH LIFT DEVICES, AND TO THE PREDICTION OF THE FULLSCALE AERODYNAMIC CHARACTERISTICS OF AN AIRPLANE WITH A SUPERCRITICAL WING. BOTH MILITARY AIRCRAFT AND COMMERCIAL TRANSPORT AIRCRAFT APPLICATIONS ARE TO BE INVESTIGATED.

RTOP NO. 789-10-11 TITLE: ADVANCED MISSION STUDIES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: DENNIS, D. H. TEL. 415-961-1111
TECHNICAL SUMMARY

STUDIES ARE CONDUCTED OF ATTRACTIVE FUTURE AERONAUTICAL AND SPACE SYSTEMS AND MISSIONS. THE OBJECTIVE OF THE STUDY ACTIVITY IS TO DEFINE DESIRED FUTURE TECHNOLOGICAL CAPABILITIES ASSOCIATED WITH SUCH SYSTEMS AND MISSIONS TO AID IN THE PLANNING OF OART RESEARCH AND TECHNOLOGY PROGRAMS. STUDIES ARE CONDUCTED IN-HOUSE AND BY CONTRACTORS, AS APPROPRIATE. THE WORK IS DONE IN CONJUNCTION WITH PARALLEL ACTIVITIES IN ECONOMIC ANALYSIS (RTOP 130-06-02), AND AERONAUTICAL PROGRAM ANALYSIS (RTOP 130-06-03).

RTOP NO. 789-40-10 TITLE: REUSABLE NUCLEAR STAGE
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: HARRIS, R. J. TEL. 205-453-5584
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROJECT IS THE DEVELOPMENT OF A REUSABLE EARTH ORBIT BASED STAGE POWERED BY THE NERVA NUCLEAR ENGINE. THIS REUSABLE NUCLEAR STAGE WILL BE USED TO SHUTTLE MANNED OR UNMANNED PAYLOADS BETWEEN THE BASE ORBIT AND LUNAR AND GEOSYNCHRONOUS ORBITS, TO LAUNCH UNMANNED DEEP SPACE PROBES, AND TO PROVIDE PROPULSION FOR THE MAJOR MANEUVERS OF MANNED PLANETARY MISSIONS. CURRENT STUDY EFFORTS ARE INVESTIGATING TWO DIFFERENT REUSABLE NUCLEAR STAGE (RNS)

DESIGN APPROACHES. THE BASELINE APPROACH IS AN INTEGRAL, 33-FOOT DIAMETER CONCEPT LAUNCHED ON AN INT-21 WITH FUEL BEING PROVIDED BY SUBSEQUENT SPACE SHUTTLE FLIGHTS. A SECOND APPROACH IS A TOTALLY SPACE SHUTTLE BASED CONCEPT WHEREIN A PROPULSION MODULE, NECESSARY PROPELLANT MODULES, AND FUEL ARE ALL DELIVERED TO ORBIT VIA THE FULLY REUSABLE SPACE SHUTTLE. ALTERNATIVE DESIGN CONCEPTS ARE BEING CONSIDERED WITHIN EACH OF THESE TWO DIFFERENT APPROACHES, INCLUDING VARYING THE PAYLOAD CAPABILITY AND CARGO BAY SIZE OF THE SPACE SHUTTLE. ONE CONCEPT IN BETWEEN THE TWO EXTREME APPROACHES WHICH HAS SEVERAL ADVANTAGES IS A SO-CALLED HYBRID RNS WHERE THE BASIC PROPELLANT TANK (33-FT. DIAMETER) IS FLOWN TO ORBIT ON AN INT-21 AND THE NERVA ENGINE AND A SMALLER PROPELLANT MODULE ARE SUBSEQUENTLY BROUGHT TO ORBIT IN A SPACE SHUTTLE AND DOCKED TO THE LARGE TANK. INITIAL STUDIES OF THE RNS WERE INITIATED IN OCTOBER, 1969 VIA THE REORIENTATION OF EXPENDABLE NUCLEAR STAGE STUDIES BEGUN IN JULY, 1969. THESE STUDIES HAVE BEEN CONTINUED WITH FY 70 FUNDS, WITH THE STUDIES FOCUSED ON A NARROWED RANGE OF SPECIFIC RNS CONCEPTS. IT IS PLANNED TO USE FY 71 FUNDS TO PROVIDE CONTINUED STAGE RELATED SUPPORT TO THE ENGINE CONTRACTOR AND TO PERFORM STUDIES IN SPECIFIC PROBLEM AREAS PRIOR TO THE INITIATION OF PHASE B STUDIES IN FY 72.

RTOP NO. 908-41-02 TITLE: SPACE STATION: SPACE VEHICLE THERMAL CONTROL

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: GUY, W. W. TEL. 713-483-2351

TECHNICAL SUMMARY

SPACE STATION THERMAL CONTROL REQUIREMENTS UNIQUELY DIFFER FROM PREVIOUS SPACECRAFT DESIGNS BECAUSE OF THE VEHICLE SIZE, MULTIMISSION CAPABILITY, LONG LIFETIME REQUIREMENTS, ETC. THE OVERALL VEHICLE THERMAL MANAGEMENT SYSTEMS FOR THE STATION MUST BE FLEXIBLE AND ADAPTABLE ENOUGH TO ACCOMMODATE CHANGES IN MISSIONS AND CONFIGURATIONS AND MUST EFFICIENTLY UTILIZE AVAILABLE HEAT SOURCES AND SINKS. THE DESIGN OF LARGE MANNED SPACE STATION FACILITIES FOR EXTENDED MISSION DURATIONS MUST BE SUPPORTED BY THE DEVELOPMENT OF IMPROVED THERMAL CONTROL CONCEPTS, PARTICULARLY IN THE AREA OF HEAT REJECTION. POTENTIAL RADIATIVE HEAT REJECTION CONCEPTS INCLUDE A MODULAR RADIATOR CONFIGURATION WHICH UTILIZES 2-DIMENSIONAL FLOW STAGNATION AND/OR HEAT PIPES FOR HEAT LOAD CONTROL. HEAT PIPES ALSO OFFER POTENTIAL FOR INCREASING THE EFFECTIVENESS OF SPACECRAFT AND EQUIPMENT THERMAL CONTROL BY MINIMIZING WEIGHT, POWER, AND MAINTENANCE REQUIREMENTS. EFFORT TO BE CONDUCTED UNDER THIS RTOP WILL BE DIRECTED TOWARD THE DEVELOPMENT OF BREADBOARD MODELS OF ADVANCED RADIATOR AND/OR HEAT PIPE SYSTEM CONCEPTS OF THE MODULAR TYPE, WHICH CAN BE SUBJECTED TO TESTING FOR FEASIBILITY ESTABLISHMENT.

RTOP NO. 908-41-07 TITLE: SPACE STATION - COMMUNICATIONS

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: KOSINSKI, R. E. TEL. 713-483-2871

TECHNICAL SUMMARY

PROVIDE COMMUNICATION SYSTEM ANALYSIS AND EVALUATION OF COMMUNICATIONS SYSTEM DESIGN CONFIGURATION AND FUNCTIONAL REQUIREMENTS OF THE SPACE STATION. MAXIMIZE EFFECTIVENESS OF EXISTING SYSTEMS AND APPLY NEW TECHNOLOGY FOR SOLUTIONS TO SPECIFIC DEVELOPMENT PROBLEMS CONCERNING RF LINK TRANSMISSION/RECEPTION, RF EQUIPMENT INCLUDING ANTENNA SYSTEMS, AND SPACE STATION INTERNAL COMMUNICATIONS SUBSYSTEMS AND COMPONENTS. ANALYZE, EVALUATE AND RESOLVE SIGNIFICANT COMMUNICATIONS SYSTEM PERFORMANCE AND INTERFACE PROBLEMS FOR HIGH DATA RATES AND DEVELOP MODELS TO SIMULATE TOTAL SYSTEM INTEGRATION. DEVELOP TECHNIQUES FOR EFFICIENT ENCODING/ERROR CORRECTION CODING OF DIGITAL COMMUNICATIONS; DETERMINE THE MOST PRACTICABLE HIGH GAIN ANTENNA CONFIGURATION REQUIRED ON THE SPACE STATION TERMINAL FOR RELAY SATELLITE COMMUNICATIONS; AND PERFORM ENGINEERING EVALUATION OF SPECIFIC COMMUNICATION PROBLEM AREAS SUCH AS AUDIO, DATA, AND RF PROCESSING FUNCTIONS FOR NEW REQUIREMENTS ASSOCIATED WITH SPACE STATION.

RTOP NO. 908-42-01 TITLE: SPACE SHUTTLE - THERMAL PROTECTION SYSTEMS

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: GREENSHIELDS, D. TEL. 713-483-3676

TECHNICAL SUMMARY

THE PROCESS OF DESIGN, PERFORMANCE ANALYSIS AND REDESIGN OF A

THERMAL PROTECTION SYSTEM (TPS) IS AN ITERATIVE ONE WHICH INVOLVES THE CONSTANT FLOW OF CHANGE REQUIREMENTS BETWEEN THE DESIGN AND EVALUATION GROUPS TO ESTABLISH AN ACCEPTABLE SYSTEM DESIGN. DESIGN TRADE-OFFS AND WEIGHT COMPARISONS BETWEEN THE DIFFERENT METALLIC AND NON-METALLIC TPS ARE BEING MADE; HOWEVER, TO OBTAIN VALID RESULTS THESE COMPARISONS HAVE TO BE MADE ON OPTIMUM DESIGNS. A TPS OPTIMIZATION PROCEDURE WILL REDUCE THE NUMBER OF THESE ITERATIONS AND WILL QUICKLY ESTABLISH WEIGHT DRIVERS AND IDENTIFY DESIGN CONSTRAINTS. UNDER THIS RTOP WORK WILL CONTINUE ON THE DEVELOPMENT OF A TPS OPTIMIZATION PROCEDURE INITIATED IN FY-70. THE SUCCESSFUL USE OF ABLATIVE MATERIALS AS PRIMARY THERMAL PROTECTION ON GEMINI AND APOLLO SPACECRAFT HAS PROVIDED HIGH CONFIDENCE IN AND KNOWLEDGE OF LOW DENSITY ABLATIVE PROTECTION. USE OF LOW DENSITY ABLATORS ON RIGID, REPLACEABLE PANELS IS CURRENTLY BEING STUDIED FOR SHUTTLE APPLICATION; AND, A CONCEPT FOR A SIMILAR, BUT STRUCTURALLY COMPLIANT AND PROBABLY MORE UTILE COVERING, HAS BEEN PROPOSED. THE PARTICULAR CONCEPT IS DESCRIBED IN A DOCUMENT ENTITLED "IMPREGNATED CARPET CONCEPT FOR A REENTRY HEAT SHIELD," BY C. C. JOHNSON, MANNED SPACECRAFT CENTER, DATED AUGUST 1967. UNDER THIS RTOP, EXPLORATORY DESIGN AND DEVELOPMENT OF THE PROPOSED CONCEPT WILL BE PURSUED.

RTOP NO. 908-42-02 TITLE: SPACE SHUTTLE - THERMAL CONTROL
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: GUY, W. W. TEL. 713-483-2351
TECHNICAL SUMMARY

THE OVERALL VEHICLE THERMAL MANAGEMENT SYSTEMS FOR THE SHUTTLE MUST BE FLEXIBLE AND ADAPTABLE ENOUGH TO ACCOMMODATE CHANGES IN MISSIONS AND CONFIGURATIONS AND MUST EFFICIENTLY UTILIZE AVAILABLE HEAT SOURCES AND SINKS. THE MULTI-MISSION REQUIREMENT FOR THE SHUTTLE PRESENTS PARTICULAR DESIGN PROBLEMS IN THERMAL CONTROL DUE TO: (1) LIFE-CYCLE CONSIDERATIONS, AND (2) THE WIDE RANGE OF REQUIRED OPERATING CONDITIONS VARYING FROM THOSE SIMILAR TO CONVENTIONAL AIRCRAFT, TO SPACECRAFTS SUBJECTED TO BOOST, ORBITAL, AND REENTRY THERMAL CONDITIONS. THE OBJECTIVE OF THIS RTOP IS TO DEVELOP CANDIDATE THERMAL CONTROL CONCEPTS WHICH OFFER POTENTIAL SOLUTIONS FOR THESE TWO NEW SHUTTLE DESIGN PROBLEMS. THE DEVELOPMENT OF A SIMPLIFIED EVAPORATOR DESIGN WHICH CAN FUNCTION WITH MULTIPLE EVAPORANTS WILL BE PURSUED. LABORATORY TEST MODELS WILL BE USED TO VERIFY DESIGN CONCEPT FEASIBILITY. A HEAT REJECTION SYSTEM WHICH CAN ACCOMMODATE THE SHUTTLE MULTI-MISSION OPERATION REQUIREMENT WILL BE DESIGNED, FABRICATED, AND TESTED. THE PRIMARY CANDIDATE IS A VAPOR COMPRESSION-MECHANICAL REFRIGERATION SYSTEM. HEAT PIPE THERMAL CONTROL SYSTEMS OFFER THE POTENTIAL FOR LONG LIFE AND TROUBLE FREE HEAT TRANSPORT AND REJECTION AT LOW WEIGHTS FOR SPACE SHUTTLE EQUIPMENT COOLING APPLICATIONS. INVESTIGATION OF ADVANCED THERMAL CONTROL TECHNIQUES APPLICABLE TO THE UNIQUE SPACE SHUTTLE ENVIRONMENT AND REUSE APPLICATIONS WILL BE PURSUED TO PROVIDE THERMAL CONTROL DESIGN OPTIONS FOR THE SHUTTLE VEHICLE.

RTOP NO. 908-42-12 TITLE: SPACE SHUTTLE - DISPLAY
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: KOSINSKI, R. TEL. 713-483-2871
TECHNICAL SUMMARY

PROVIDE DEFINITION, DESIGN AND DEVELOPMENT OF AN ON-BOARD, COMPATIBLE COLOR TELEVISION CAMERA, DISPLAY SYSTEM (TV MONITOR) AND A COMMAND SYSTEM COMPATIBLE WITH THE SPACE SHUTTLE/STATION REQUIREMENTS. AN ANALYTICAL STUDY WILL BE PERFORMED TO DETERMINE THE OPTIMUM CHARACTERISTICS FOR COLOR IMPLEMENTATION OF THE SHUTTLE ONBOARD CLOSED CIRCUIT TV. ENGINEERING BREADBOARD MODELS OF THE TV CAMERA AND MONITOR THEN WILL BE FABRICATED, TESTED, AND EVALUATED IN THE MSC LABORATORIES TO ESTABLISH SPECIFICATIONS FOR THE RECOMMENDED SYSTEM, CONSIDERING SUCH FACTORS AS: COMPLEXITY, COST, WEIGHT, FLEXIBILITY FOR RF LINK TRANSMISSION, ETC. MAXIMUM USAGE WILL BE MADE OF ANY APPLICABLE COMPONENTS AND EXPERIENCE FROM THE APOLLO COLOR TV DEVELOPMENT PROGRAM. IN ADDITION, AN ENGINEERING MODEL OF A COMMAND SYSTEM DECODER WILL BE FABRICATED AND EVALUATED IN MSC LABORATORIES TO CONFIRM COMPATIBILITY WITH SHUTTLE UPLINK, RELIABILITY, AND DATA BUS INTERFACES. AT THE COMPLETION OF THESE EFFORTS, TECHNICAL PERFORMANCE SPECIFICATIONS WILL BE AVAILABLE FOR PROTOTYPE FLIGHT EQUIPMENTS.

RTOP NO. 908-42-18 TITLE: SPACE SHUTTLE - CHECKOUT
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: MARLOWE, G. D. TEL. 713-483-6196
TECHNICAL SUMMARY

THE PRESENT CONCEPT OF GROUND CHECKOUT SYSTEMS FOR MANNED SPACECRAFT IS NOT CONSISTENT WITH THE SPACE SHUTTLE PROGRAM GOALS OF REDUCED COSTS FOR DEVELOPMENTAL AND OPERATIONAL GROUND TEST SUPPORT. THE SHUTTLE VEHICLE PROGRAM PRESENTS UNIQUE REQUIREMENTS FOR GROUND TEST IN THAT IT IS A PHASED PROGRAM CONSISTING OF AN R&D PHASE FOLLOWED BY AN OPERATIONAL RE-USE/REFURBISH PHASE. THIS EFFORT PROVIDES FOR THE DEVELOPMENT OF A UNIVERSAL TEST CONSOLE AND RF GSE TEST SYSTEM WHICH WILL REDUCE GROUND TEST COSTS BY REDUCING HARDWARE INVENTORY, SIMPLIFYING INTERFACES TO THE TEST ARTICLE, AND PROVIDE MORE EFFICIENT OPERATIONS AS A RESULT OF IMPROVED MAN/MACHINE INTERFACE AND INTEGRATED CONTROL AND MONITOR OF OTHER VEHICLE SUPPORT GSE. THE UNIVERSAL TEST EQUIPMENT CONSOLE PROVIDES FOR UTILIZATION DURING VENDOR TESTING TO REDUCE SPECIAL TEST EQUIPMENT REQUIREMENTS WITH THE CAPABILITY FOR EXPANSION TO MEET INTEGRATED AND ACCEPTANCE TEST/PRE-LAUNCH OPERATIONS WITH SIGNIFICANTLY LESS HARDWARE THAN NOW USED FOR APOLLO. SYSTEM DEVELOPMENT IN THE AREA OF MAN/MACHINE INTERFACE PROVIDES CONTROL AND DISPLAY TECHNIQUES WHICH ALLOWS REDUCTION OF TEST OPERATIONS PERSONNEL. THE UNIVERSAL TEST EQUIPMENT CONSOLE MAN/MACHINE INTERFACE WILL BE DESIGNED TO BE OPERATED BY A MINIMUM NUMBER OF PERSONNEL AND STRUCTURED SO THAT EXHAUSTIVE SPECIALIZED TRAINING WILL NOT BE REQUIRED TO PERFORM TEST OPERATIONS.

RTOP NO. 908-51-02 TITLE: SPACE STATION THERMAL CONTROL
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

SPACE THERMAL CONTROL IS A VITAL AREA OF NASA'S R&D PROGRAM BECAUSE OF ENVIRONMENTAL TEMPERATURE REQUIREMENTS NECESSARY FOR LIFE SUPPORTS AND FOR EQUIPMENT OPERATION. THIS IS ESPECIALLY TRUE FOR THE SPACE STATION SINCE LIFETIMES OF 5-10 YEARS ARE REQUIRED. THE FIELD OF THERMAL CONTROL OF SPACECRAFT IS BROAD AND INCLUDES SUCH AREAS AS COATINGS AND METALIZED POLYMERS, HEAT PIPES, FUSIBLE MATERIALS, FLUID LOOPS AND RADIATING FINS. THIS RTOP IS DIRECTED PRIMARILY TOWARD COATINGS AND METALIZED POLYMERS WHICH ARE REQUIRED FOR BOTH PASSIVE AND ACTIVE THERMAL CONTROL SYSTEMS. STUDIES OF BOTH OF THESE MAJOR TYPES OF THERMAL CONTROL SURFACES WILL BE MADE TO EXAMINE THEIR APPLICABILITY FOR SPACE STATION USAGE. INTEGRATED HEAT PIPE SYSTEMS WILL ALSO BE STUDIED TO ASSURE THAT ADVANCED CONCEPTS ARE DEVELOPED FOR OPTIMUM UTILIZATION OF THIS SYSTEM.

RTOP NO. 908-51-04 TITLE: SPACE STATION ATTITUDE CONTROL PROPULSION SYSTEM
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

THIS PLAN IS TO ESTABLISH THE ATTITUDE CONTROL PROPULSION SYSTEM (ACPS) DESIGN OPERATIONAL METHODOLOGY AND COMPONENT REQUIREMENTS TO SATISFY THE MANNED SPACE STATION REQUIREMENTS AND DEMONSTRATE THE NECESSARY COMPONENT, SYSTEM AND OPERATIONAL TECHNOLOGY BY THE BEGINNING OF 1972. THIS EFFORT IS NECESSARY TO PROVIDE THE CAPABILITY TO MEET THE LONG DURATION AND LARGE IMPULSE NEEDS OF THE SPACE STATION WITH A MINIMUM OF CREW ACTIVITY FOR REFURBISHMENT AND RESUPPLY. THESE OBJECTIVES WILL BE ACCOMPLISHED BY A LOGICAL SEQUENCE OF REQUIREMENTS DEFINITION AND ANALYSIS, COMPONENT AND SYSTEM DESIGN AND TRADEOFF STUDIES, AND EXPERIMENTAL DEMONSTRATION OF BREADBOARD COMPONENTS AND SYSTEMS. THE FY'71 EFFORT WILL EXTEND THE ACPS REPAIR, RESUPPLY, AND MAINTENANCE CONTRACTS BEGUN IN PREVIOUS FISCAL YEARS.

RTOP NO. 908-51-05 TITLE: ELECTRICAL POWER
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

THIS RTOP SETS FORTH A SERIES OF CAREFULLY PLANNED TESTS THAT PURSUE TECHNOLOGY DEVELOPMENT AND ESTABLISH TECHNOLOGY REQUIREMENTS NEEDED TO INTEGRATE NUCLEAR POWER CONVERSION UNITS INTO THE SPACE STATION/SPACE BASE. PERFORMANCE TESTING WILL BE CONDUCTED INHOUSE TO SOLVE THE SYSTEM INTERFACE REQUIREMENTS AND TO DEVELOP AUTOMATIC CONTROL EQUIPMENT, AUXILIARY POWER EQUIPMENT; ALSO, DEVELOP CIRCUITRY AND POWER CONVERSION COMPONENTS AS RELATED TO NUCLEAR POWER. THE TEST RESULTS WILL BE USED TO INFLUENCE THE PROGRAMS FOR THE RESPECTIVE TECHNOLOGIES ADMINISTERED BY MSFC, MSC, AND LERC. THIS IS

A CONTINUATION OF THE PRESENT PROGRAM. NECESSARY EQUIPMENT FOR THE CONSTRUCTION OF TEST LOOPS TO BE FABRICATED INHOUSE HAVE BEEN PURCHASED. THIS PROPOSAL IS FOR THE REQUIRED FUNDING TO COMPLETE THE PURCHASE OF THE TEST ARTICLES AND THE SPECIAL INTERFACE EQUIPMENT. ALSO, LIMITED EFFORT IS BEING DIRECTED TOWARD THE DEVELOPMENT OF TECHNIQUES FOR GENERATING TRANSMITTING AND RECEIVING MICROWAVE ENERGY.

RTOP NO. 908-51-08 TITLE: STABILIZATION AND CONTROL
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

FUTURE SPACE STATION MISSIONS WILL REQUIRE CONTROL MOMENT GYROS LARGER THAN THOSE NOW AVAILABLE HAVING ATTENDED LIFE TIME, REPAIR AND REFURBISHMENT REVISIONS, AND MEANS FOR DETECTING IMPENDING FAILURES, INCORPORATED INTO A TOTAL CONTROL SYSTEM CAPABLE OF FUNCTIONING THROUGHOUT A TEN YEAR LIFE SPAN DURING WHICH TIME THE STATION CONFIGURATION UNDERGOES MAJOR CHANGES AS EXPERIMENT AND RESUPPLY MODULES ARE DOCKED AND UNDOCKED. CONTROL MUST ALSO BE PROVIDED DURING PERIODS OF ARTIFICIAL GRAVITY OPERATION WHEN THE VEHICLE IS SPINNING. THE BASIC TECHNICAL AREAS TO BE COVERED ARE: 1) ZERO GRAVITY CONTROL SYSTEM DEFINITION AND DESIGN; 2) ARTIFICIAL GRAVITY CONTROL SYSTEM DEFINITION AND DESIGN; 3) LONG-LIFE CONTROL MOMENT GYRO DEVELOPMENT.

RTOP NO. 908-51-18 TITLE: CHECKOUT
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

THE WORK DESCRIBED WILL PROVIDE TECHNOLOGY FOR DEVELOPING CHECKOUT SYSTEMS AND TECHNIQUES. PROBLEMS IN FUNCTIONAL TESTING, SYSTEM INTEGRITY AND CHECKOUT PRINCIPLES WILL BE IDENTIFIED, AND SOLUTIONS DEVELOPED, AS SPACE STATION AND DEEP SPACE EXPLORATION VEHICLES ARE DESIGNED AND BUILT. OF SPECIFIC INTEREST IS THE DEVELOPMENT OF LEAK DETECTION TECHNIQUES FOR AEROSPACE HARDWARE WHICH ARE MORE RELIABLE THAN EXISTING TECHNIQUES, AND WHICH DO NOT REQUIRE THE PHYSICAL PRESENCE OF AN INSPECTOR AT THE TIME THE SYSTEM IS PRESSURIZED AND POSSIBLE LEAKING. TWO APPROACHES WILL BE TAKEN. ONE APPROACH IS TO FIND OR DEVELOP AN ELASTOMER PAINT THAT CAN BE APPLIED TO POTENTIAL LEAK POINTS. THIS PAINT WILL BLISTER AND FORM BALLOONED OR RUPTURED STRETCHED AREAS EASILY SEEN BY VISUAL INSPECTION FOLLOWING THE PRESSURE CYCLE. THE SECOND APPROACH WHICH WILL BE CURRENTLY PURSUED IS THE SELECTION OF A GAS WHICH, WHEN ADDED IN SMALL QUANTITIES TO COMMON PRESSURANTS, WILL REACT WITH AN EXTERNAL TAPE WHICH IS CHEMICALLY IMPREGNATED WITH AN INDICATOR CHEMICAL AND CAUSE THE TAPE TO CHANGE COLOR.

RTOP NO. 908-51-33 TITLE: DATA MANAGEMENT
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

A VIGOROUS RESEARCH AND DEVELOPMENT EFFORT WILL BE PURSUED IN THE AREAS OF ADVANCED DATA MANAGEMENT SYSTEMS. INCLUDED ARE THE RESEARCH AND DEVELOPMENT OF ADVANCED AEROSPACE COMPUTERS, INCLUDING MULTIPROCESSORS/MULTICOMPUTERS SYSTEMS FOR ONBOARD APPLICATION, ADVANCED COMPUTER PERIPHERAL DEVICES SUCH AS DISPLAYS, HISTORY PLOTTERS, KEYBOARDS AND HARDCOPY DEVICES, AND HIGH LEVEL COMPUTER/SCIENTIST LANGUAGES TO FACILITATE MAN-MACHINE INTERACTION. RELATED TO THE EFFORT WILL BE THE FUNCTIONAL SPECIFICATION OF EXECUTIVE SYSTEMS FOR SEVERAL DIFFERENT TYPES OF SPACEBORNE COMPUTER ORGANIZATIONS SUCH AS THOSE PROPOSED FOR THE SPACE STATION BY INDUSTRY AND NASA CENTERS. INTERACTION BETWEEN ANTICIPATED WORK LOAD AND HARDWARE WILL BE EVALUATED.

RTOP NO. 908-51-38 TITLE: MATERIALS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS CONTRACT EXTENSION ARE TO DEVELOP TECHNIQUES AND CONCEPTS NECESSARY TO MECHANICALLY AND ELECTRICALLY APPLY PROVEN THIN FILM THERMOELECTRIC DEVICES AS SPACECRAFT THERMAL CONTROL COATINGS. DURING THE TIME FROM JAN. 20, 1970 - MAY 6, 1970 THE CONTRACTOR HAS PERFORMED THE FOLLOWING STEPS NECESSARY IN EXPERIMENTALLY APPLYING THERMOELECTRIC DEVICES AS SPACECRAFT THERMAL CONTROL COATINGS: (1) OPTIMIZED THE SEMICONDUCTOR ELEMENT PARTICLE SIZE USED IN SELECTED VAPOR DEPOSITED PROCESSES, (2) EVALUATED THE CLOSE-SPACED AND FLASH EVAPORATION TECHNIQUES AS MEANS OF FORMING THIN FILM ARRAYS, (3) EVALUATED THE FIGURE-OF-MERIT FOR A DEVICE DEPOSITED ON A GLASS SUBSTRATE, AND (4) FAVORABLY COMPARED CALCULATED AND EXPERIMENTAL POWER GENERATION, HEAT FLOWS, AND FIGURE-OF-MERITS FOR FORMED DEVICES. IN-HOUSE WORK INCLUDED PURCHASE OF A COMPARATIVE TYPE SOLIDS THERMAL CONDUCTIVITY MEASURING SYSTEM AND SUBSEQUENT CHECKOUT OF THIS SYSTEM, FABRICATION OF STANDARDS FOR THIS SYSTEM WHICH ARE NECESSARY FOR SEMICONDUCTOR THERMAL CONDUCTIVITY WORK, AND THE THEORETICAL AND EXPERIMENTAL DESIGN OF AN EXPERIMENT TO MEASURE THE EFFECT OF APPLIED LOW ENERGY ELECTROMAGNETIC RADIATION UPON THERMAL PROPERTIES OF SEMICONDUCTOR MATERIAL.

RTOP NO. 908-52-01 TITLE: REUSABLE SPACE SHUTTLE VEHICLE STRUCTURAL SYSTEMS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 202-453-1120
TECHNICAL SUMMARY

OBJECTIVE: TO PERFORM SUPPORTING TECHNOLOGY ACTIVITIES IN THE ADVANCED STRUCTURAL CONCEPTS AND MATERIALS SYSTEMS AREAS APPLICABLE TO A REUSABLE SPACE SHUTTLE VEHICLE.

RTOP NO. 908-52-02 TITLE: THERMAL CONTROL
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

THE SPACE SHUTTLE VEHICLE THERMAL PROTECTION SYSTEM DESIGN IS BEING SUPPORTED BY PARAMETRIC TPS STUDIES AND STUDIES RELATING TO ACTIVE STRUCTURAL COOLING SYSTEMS TO MEET THE POST 1975 FLIGHT SCHEDULE. IN GENERAL, THIS EFFORT IS BEING DIRECTED TOWARD THE DEVELOPMENT OF EFFICIENT TPS AND ENVIRONMENTAL CONTROL SYSTEMS TO PRECLUDE LOSS OF PAYLOAD CAPABILITY AND TO ASSURE COST EFFECTIVENESS.

RTOP NO. 908-52-03 TITLE: SPACE SHUTTLE MAIN PROPULSION
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

THIS RTOP COVERS AREAS OF SPACE SHUTTLE RELATED RESEARCH AS FOLLOWS: (1) ON-BOARD CHECKOUT AND MONITORING SYSTEM TO ESTABLISH THE PROPULSION SYSTEMS "ON-BOARD" CHECKOUT, IN FLIGHT MONITORING, EMERGENCY DETECTION AND POSTFLIGHT EVALUATION SYSTEM CONFIGURATION AND REQUIREMENTS AND TO DETERMINE THERE FROM THE ENGINE AND VEHICLE SPECIFICATION REQUIREMENTS AND DESIGN CRITERIA. THE SYSTEM WILL ENABLE THE CREW TO DETERMINE THE FLIGHT WORTHINESS OF THE VEHICLE AND ITS COMPONENTS, PROVIDE A WARNING OF ACTUAL AND IMPENDING MALFUNCTIONS AND ASSIST IN THE REFURBISHMENT AND REPLACEMENT EFFORT BETWEEN FLIGHTS AND REDUCE OPERATIONAL COST. THE STUDY WILL INCLUDE THE MAIN, AUXILIARY AND AIR BREATHING PROPULSION SYSTEMS; AND (2) TURBOPUMP COMPONENT TECHNOLOGY TO PROVIDE A DEVICE CAPABLE OF SENSING SHAFT, IMPELLER AND TURBINE WHEEL DEFLECTIONS AT HIGH ROTATIONAL SPEEDS WITHOUT REQUIRING PORTS OR MECHANICAL INTERCONNECTS BETWEEN THE SENSOR AND INTERNAL ROTATING COMPONENT.

RTOP NO. 908-52-08 TITLE: STABILIZATION AND CONTROL
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO DETERMINE THE BEST (OPTIMUM) CONTROLLER WHICH WILL ADEQUATELY STABILIZE AND CONTROL THE ATTITUDE MOTION OF A SPACE SHUTTLE VEHICLE FOR THE VARIED FLIGHT ENVIRONMENTS: (1) LAUNCH/ATMOSPHERIC FLIGHT, (2) REENTRY FLIGHT, (3) ORBITAL ENVIRONMENT, AND (4) LANDING. THE APPROACHES WILL EMPHASIZE AUTOMATIC CONTROL SYSTEMS WITH MAN SERVING AS BACKUP FOR EMERGENCIES. CONSIDERATION WILL BE GIVEN TO IMPLEMENTING THE CONTROL BY CONVENTIONAL, ADAPTIVE AND FOR OPTIMAL CONTROL TECHNIQUES WITH RELIABILITY AND SIMPLICITY AS THE DESIGN CRITERIA. THE OBJECTIVE OF THE ANALYSES WILL REQUIRE THE DEVELOPMENT OF FLEXIBLE ANALYSIS TECHNIQUE CAPABLE OF MEETING THE WIDE RANGE OF SHUTTLE VEHICLE MISSIONS THAT ARE UNDER CONSIDERATION. THE RECENT ADVANCES IN APPLYING MODERN CONTROL THEORY TO COMPLEX HIGH ORDER SYSTEMS HAVE CREATED THE OPPORTUNITY TO DEVELOP A TECHNIQUE THAT WOULD GREATLY REDUCE THE TIME (BOTH ENGINEERING AND COMPUTER) AND EFFORT NECESSARY

TO DESIGN EFFECTIVE CONTROLLERS FOR GIVEN SPACE APPLICATION.

RTOP NO. 908-52-10 TITLE: GUIDANCE AND NAVIGATION

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

LASER RENDEZVOUS AND DOCKING COMPONENTS WILL BE DEVELOPED, EVALUATED, AND FLIGHT QUALIFIED IN TIME FOR INCORPORATION INTO SPACE SHUTTLE GUIDANCE AND NAVIGATION SYSTEMS. SOURCES WILL ALSO BE ESTABLISHED FOR IMU SENSORS THAT MEET SPACE SHUTTLE IMU REQUIREMENTS, AND A PROGRAM WILL BE DEVELOPED FOR DETERMINING FUEL OPTIMUM TRAJECTORIES FOR REUSABLE LIFTING.

RTOP NO. 908-52-37 TITLE: CRYOGENICS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

THIS PLAN WILL PROVIDE TECHNOLOGY TO PROVIDE CONSISTENT DESIGN CRITERIA AND CONCEPTS FOR EFFICIENT UTILIZATION AND CONTROL OF CRYOGENS ABOARD THE SPACE SHUTTLE VEHICLE. EFFORTS PERFORMED UNDER THIS RTOP WILL ESTABLISH THE DESIGN AND SUBSYSTEM INTEGRATION CRITERIA AND PROTOTYPE HARDWARE NECESSARY TO MINIMIZE PERFORMANCE DEVIATION WITH EXTENDED OPERATIONAL LIFE AND REUSE. THE LONG TERM CRYOGEN SUBSYSTEMS THAT REQUIRE TECHNOLOGICAL DEVELOPMENT INCLUDE (A) PASSIVE OR CAPILLARY PROPELLANT ACQUISITION DEVICES, (B) ZERO-G VENT SYSTEM AND (C) DESTRATIFICATION MIXER SYSTEMS. THIS PLAN IS COMPLEMENTARY TO RESEARCH AND TECHNOLOGY OPERATIONS AND PLANS ON ZERO-G MASS GAGING; INTERNAL/EXTERNAL/COMPOSITE INSULATION; ORBITAL EXPERIMENTS-PROPELLANT TRANSFER AND ATTITUDE PROPULSION SYSTEM.

RTOP NO. 908-52-38 TITLE: MATERIALS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MILES, G. TEL. 205-453-1120

TECHNICAL SUMMARY

1. CRYOGENIC INSULATION SYSTEMS NOW IN USE ON SPACE VEHICLES ARE REQUIRED TO PERFORM ONLY ON ONE MISSION. FOR THE REUSABLE SHUTTLE THESE INSULATION SYSTEMS WILL HAVE TO PERFORM FOR NUMEROUS MISSIONS WITH MINIMUM REFURBISHMENT AND/OR REPLACEMENT. TO MEET THESE REQUIREMENTS IT WILL BE NECESSARY TO DEVELOP AND EVALUATE CRYOGENIC INSULATION MATERIALS TO PROVIDE THE THERMAL PROTECTION REQUIRED IN PARTICULAR AREAS AS SPECIFIC INFORMATION IS DEVELOPED. THE FOLLOWING AREAS REQUIRE STUDY: A. DEVELOPMENT OF ADVANCED MATERIALS COMPOSITES FOR USE AS INTERNAL INSULATION FOR LH2 TANKS (FOAM) (INITIATED FY-70) B. DEVELOPMENT OF ADVANCED MATERIALS COMPOSITES FOR USE AS INTERNAL INSULATION FOR LH2 TANKS (GAS LAYER) (INITIATED FY-70) 2. THE ALL RE-USABLE GROUND RULE FOR THE SPACE SHUTTLE IMPOSES TECHNOLOGICAL REQUIREMENTS ON MATERIALS SIGNIFICANTLY GREATER THAN PREVIOUS SINGLE FLIGHT OPERATIONS. IN ORDER TO

ACCOMPLISH ADEQUATE SHUTTLE MATERIALS REUSE EVALUATION, AT LEAST TWO PHASES OF EFFORT ARE REQUIRED: OTHERS FOLLOW AS SUPPORT IS OBTAINED.

A. KNOWLEDGE OF MATERIALS DEGRADATION PHENOMENA - INCLUDING THE EFFECTS OF FLAWS, CRACKS, OXIDIZED SURFACES ON STRENGTH OR THE ABILITY OF A COMPONENT TO FULFILL ITS FUNCTION. B. DEVELOPMENT OR ESTABLISHMENT OF REPAIR METHODS, REPLACEMENT PROCEDURES, OR OTHER CORRECTIVE MEASURES, INCLUDING PREVENTIVE MAINTENANCE. 3. DESIGN ALLOWABLE DATA ARE REQUIRED FOR EACH ALLOY, MILL PRODUCT, HEAT TREATMENT BASED ON TEMPERATURE AND ENVIRONMENTAL CONDITIONS.

RTOP NO. 908-52-39 TITLE: AEROTHERMODYNAMICS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

ONE MAJOR PROGRAM WITHIN NASA AT THE PRESENT TIME IS THE DEVELOPMENT OF THE SPACE SHUTTLE, CONSISTING OF BOOSTER AND ORBITER. UNDER PRESENT PHILOSOPHY THE MAIN GOALS ARE TO DEVELOP A LOW COST, SIMPLE AND RELIABLE CONCEPT. SINCE THE RECOVERABLE BOOSTER AND ORBITER FLY IN ALL MACH NUMBER REGIMES, A THOROUGH UNDERSTANDING OF THEIR AEROTHERMODYNAMIC BEHAVIOUR IS ESSENTIAL FOR THE SELECTION OF SPACE SHUTTLE CONCEPTS. THE PROPOSED STUDIES ARE MOSTLY EXPERIMENTAL, THUS WIND TUNNEL TESTS WILL BE RUN TO OBTAIN THE AERODYNAMIC FORCES AND OTHER CHARACTERISTICS. PHASE CHANGE COATING HEAT TRANSFER AND THERMOCOUPLE TESTS WILL BE CONDUCTED TO OBTAIN THE THERMODYNAMIC CHARACTERISTICS OF SPACE SHUTTLE CONCEPTS.

RTOP NO. 908-52-40 TITLE: AEROELASTICITY
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, G. TEL. 205-453-1120
TECHNICAL SUMMARY

TASK A: A RESEARCH TECHNOLOGY PROGRAM TO PROVIDE ACCURATE DYNAMIC MODELING RESPONSE AMPLITUDE AND LOAD CALCULATION METHODS, AND COMPUTER PROGRAMS APPLICABLE TO THE COMPLEX COMBINATIONS OF STRUCTURE, PROPULSION SYSTEMS, AND EQUIPMENT INVOLVED IN THE LAUNCH ASSEMBLIES AND ORBITAL ARRANGEMENTS FOR MANNED EARTH ORBITAL MISSIONS. TASK B: DEVELOP AND EMPIRICALLY VERIFY METHODS AND TECHNIQUES FOR DETERMINING VIBROACOUSTIC ENVIRONMENTS AND STRUCTURAL RESPONSE OF MANNED ORBITAL MISSION VEHICLE STRUCTURES. TASK C: THEORETICAL, ANALYTICAL, AND EXPERIMENTAL PROGRAMS TO DEFINE THE SPACE SHUTTLE: (A) ACOUSTIC AND AERODYNAMIC ENVIRONMENTS (B) WIND INDUCED OSCILLATIONS (GROUND WINDS ENVIRONMENT) (C) AEROELASTIC CHARACTERISTICS TASK D: (A) IMPROVE THEORY AND METHODS FOR THE CALCULATIONS OF 3-D ELASTIC BODY MODAL CHARACTERISTICS. (B) DEVELOP PROPELLANT SLOSH THEORY FOR A NEW CLASS OF VEHICLES AND IMPROVE BAFFLE PERFORMANCE.

RTOP NO. 908-67-05 TITLE: ELECTRICAL SYSTEMS
ORGANIZATION: JOHN F. KENNEDY SPACE CENTER
MONITOR: CERRATO, R. J. TEL. 305-867-6306
TECHNICAL SUMMARY

THIS RTOP IS FOR OMSF FUNDED ADVANCED DEVELOPMENT TASKS RELATED TO ELECTRICAL SYSTEMS FOR PROPOSED NEW SPACE SYSTEMS. IT PROVIDES FOR ENGINEERING INVESTIGATIONS OF PROPOSED NEW SPACE VEHICLES AND THEIR OPERATIONS TO IDENTIFY THE FUNCTIONS THAT MUST BE PERFORMED BY ELECTRICAL SYSTEMS. IT COVERS WORK TO DEFINE AND DEVELOP ELECTRICAL SYSTEMS AND COMPONENTS AND PLANS FOR THEIR ACQUISITION, OPERATION, AND LOGISTICS SUPPORT. THE DEFINITIONS MUST BE IN SUFFICIENT DETAIL TO PRODUCE CREDIBLE INFORMATION AS TO THE TECHNOLOGY REQUIRED FOR THE PROPOSED NEW SPACE VEHICLE.

RTOP NO. 908-67-09 TITLE: ABORT AND SAFETY
ORGANIZATION: JOHN F. KENNEDY SPACE CENTER
MONITOR: CERRATO, R. J. TEL. 305-867-6306
TECHNICAL SUMMARY

THIS RTOP IS FOR OMSF FUNDED ADVANCED DEVELOPMENT TASKS TO IDENTIFY, DEFINE, AND DEVELOP LAUNCH OPERATIONS ABORT AND SAFETY REQUIREMENTS FOR PROPOSED NEW SPACE SYSTEMS. IT PROVIDES FOR ENGINEERING INVESTIGATIONS TO IDENTIFY THE HAZARDS ATTENDANT TO THE SPACE VEHICLE CONFIGURATION, THE FACILITIES AND EQUIPMENT FOR ITS OPERATIONS, AND THE OPERATIONS PERFORMED WITH AND ON IT. SAFETY CRITERIA, CONSTRAINTS, REQUIREMENTS, AND SPECIFICATIONS DEVELOPMENT IS INCLUDED. IT COVERS ANALYSES AND TESTS TO PRODUCE QUANTITATIVE DATA TO USE WITH THE CRITERIA IF SUCH DATA DOESN'T ALREADY EXIST. THIS WORK SHOULD BE CARRIED ON SIMULTANEOUSLY WITH THE SPACE VEHICLE CONCEPTUAL DESIGN, GROUND OPERATIONS ANALYSIS, AND FLIGHT OPERATIONS PLANNING SO THAT ALL THE FINDINGS IN EACH AREA CAN BE ITERATED AND CROSS TRADED TO ARRIVE AT A TOTAL RESULT THAT IS AN OPTIMUM ACCOMMODATION OF ALL INTERACTING PARAMETERS.

RTOP NO. 908-67-34 TITLE: LAUNCH OPERATIONS FACILITIES AND EQUIPMENT
ORGANIZATION: JOHN F. KENNEDY SPACE CENTER
MONITOR: CERRATO, R. J. TEL. 305-867-6306
TECHNICAL SUMMARY

THIS RTOP IS FOR OMSF FUNDED ADVANCED DEVELOPMENT TASKS RELATED TO LAUNCH FACILITIES AND EQUIPMENT FOR PROPOSED NEW SPACE SYSTEMS. IT PROVIDES FOR ENGINEERING INVESTIGATIONS OF PROPOSED NEW SPACE VEHICLES AND THEIR GROUND OPERATIONS TO IDENTIFY THE FUNCTIONS THAT MUST BE PERFORMED BY LAUNCH FACILITIES, EQUIPMENT, COMPONENTS, AND MANAGEMENT SYSTEMS FOR THEIR OPERATIONAL CONTROL.

RTOP NO. 908-71-31 TITLE: STUDIES OF HUMAN PERFORMANCE IN AN
ARTIFICIAL GRAVITY ENVIRONMENT

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: DRALEY, E. C. TEL. 703-827-3285

TECHNICAL SUMMARY

IT IS THE OBJECTIVE OF THIS RESEARCH TO PROVIDE INFORMATION CONCERNING MAN'S PERFORMANCE IN AN ARTIFICIAL GRAVITY ENVIRONMENT SO THAT THE SPACE STATION AND SPACE BASE DESIGN AND DEVELOPMENT PROGRAMS MAY PROCEED ON A MORE FIRM BASE THAN THAT WHICH IS NOW AVAILABLE. AT THE PRESENT THERE IS LITTLE DATA AVAILABLE CONCERNING THE HABITABILITY OF SPACE SYSTEMS WHICH ROTATE TO PROVIDE THE CREW WITH AN ENVIRONMENT MORE CLOSELY AKIN TO THAT WHICH HE HAS BEEN ACCUSTOMED TO ON EARTH AND TO AVOID THE POSSIBLE EFFECTS OF WEIGHTLESSNESS ON HIS PHYSIOLOGICAL STATE AND PERFORMANCE CAPABILITIES. THERE ARE THOSE WHO BELIEVE THAT THE PRESENCE OF CORIOLIS FORCES, GRAVITY GRADIENTS, AND OTHER ASPECTS OF ROTATION WILL PROVIDE THE CREW WITH AN ENVIRONMENT EVEN MORE INTOLERABLE THAN THAT WHICH MIGHT BE EXPECTED IN EXTENDED WEIGHTLESSNESS. GROUND-BASED ROTATING-SPACE-STATION SIMULATORS WILL BE USED TO SIMULATE AS CLOSELY AS POSSIBLE THE ENVIRONMENTS OF THE PROPOSED SPACE BASE, SPACE STATION, AND SKYLAB II EXPERIMENTS. INVESTIGATIONS WILL BE CONDUCTED TO DETERMINE LEVELS OF SUBJECT PERFORMANCE DURING SIMPLE TASKS SUCH AS WALKING, LADDER CLIMBING, AND CARGO HANDLING. IN ADDITION TO THESE GROSS PERFORMANCE MEASUREMENTS, FINE PSYCHOMOTOR PERFORMANCE CHANGES AND ADAPTATION TO THE ENVIRONMENT WILL BE MONITORED.

RTOP NO. 914-50-50 TITLE: ADVANCED LUNAR EXPLORATION STUDIES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BURCHAM, D. P. TEL. 213-354-3028

TECHNICAL SUMMARY

THE OBJECTIVE OF ADVANCED LUNAR EXPLORATION STUDIES IS TO PROVIDE EXPLORATION PLANS AND PROJECT DESCRIPTIONS, IN ADVANCE OF PROJECT COMMITMENTS, THAT WILL ASSIST IN PLANNING THE CONTINUED EXPLORATION OF THE MOON. STUDIES OF THE SCIENTIFIC RATIONALE FOR LUNAR EXPLORATION WILL BE CONTINUED AND EXTENDED ON THE BASIS OF DATA BEING PRODUCED BY CURRENT LUNAR MISSIONS. IN FY'71 OBJECTIVES AND STRATEGY FOR POST-APOLLO LUNAR MISSIONS WILL BE DESCRIBED WITH EMPHASIS ON AUTOMATED SYSTEMS AND ON THE DEVELOPMENT OF INTERNATIONAL LUNAR ACTIVITIES. STUDIES AND PRE-PROJECT PROBLEM-SOLVING OF THE SCIENCE AND NAVIGATION ASPECTS OF LONG-RANGE, AUTOMATED LUNAR SURFACE TRAVERSE MISSIONS WILL BE CONTINUED IN COLLABORATION WITH MSFC, MSC AND THE USGS. AN OBJECTIVE OF THESE STUDIES IN FY'71 WILL BE TO COMPLETE A SERIES OF FUNCTIONAL TESTS FOR DEFINING THE OPERATING METHODS, DATA REQUIREMENTS, AND MAN-MACHINE INTERACTIONS ASSOCIATED WITH EARTH-BASED CONTROL OF A MOBILE PAYLOAD ON THE MOON. IMAGING, NAVIGATION, LUNAR MATERIAL MANIPULATION AND ANALYSIS, AND PAYLOAD DATA HANDLING WILL BE MODELED IN THESE LABORATORY AND FIELD TESTS TO THE EXTENT PRACTICAL, USING MOSTLY EXISTING EQUIPMENT AVAILABLE FROM OTHER PROGRAMS.

RTOP NO. 914-50-51 TITLE: INTERPRETATION OF APOLLO SCIENCE RESULTS
AND IMPACT ON LUNAR PROGRAM

ORGANIZATION: JET PROPULSION LAB

MONITOR: BURCHAM, D. P. TEL. 213-354-3028

TECHNICAL SUMMARY

EVALUATION OF SCIENTIFIC RESULTS OF RECENT APOLLO LUNAR MISSIONS BY CRITICAL REVIEW AND INTEGRATION OF FINDINGS FROM APOLLO 11 AND SUBSEQUENT LUNAR SAMPLE STUDIES AND LUNAR SURFACE MEASUREMENTS. THE OBJECTIVE WILL BE TO DETERMINE WHAT MAJOR SCIENTIFIC QUESTIONS REGARDING LUNAR HISTORY AND ORIGIN HAVE BEEN ANSWERED AND WHAT QUESTIONS REMAIN UNANSWERED. THE PURPOSE IS TO DETERMINE WHAT CHANGES, IF ANY, IN INVESTIGATIVE RATIONALE SHOULD BE INCORPORATED IN FUTURE SPACECRAFT AND EARTH BASED LUNAR SCIENCE INVESTIGATIONS.

RTOP NO. 914-50-52 TITLE: LUNAR EXPLORATION ANALYSES (IITRI)

ORGANIZATION: NASA HEADQUARTERS

MONITOR: MOLLOY, M. W. TEL. 202-963-4882

TECHNICAL SUMMARY

AS BACKGROUND FOR DECISIONS ON CURRENT APOLLO AND FUTURE LUNAR PROGRAMS, PREPARE PLANNING REPORTS WHICH: 1. INTERPRET APOLLO RESULTS AND ANALYZE THEIR IMPACT ON FUTURE PLANNING. 2. EVOLVE AND DEVELOP LONG-RANGE LUNAR PROGRAM PLANS RESULTING IN 10- AND 20-YEAR PLANS, AND FY '72 PROGRAM MEMORANDA. 3. CONDUCT PROGRAM PLANNING OF LUNAR SURFACE AND ORBITAL MISSIONS IN THE POST-APOLLO "GAP-FILLER" (1974-1980) AND INTEGRATED PLAN (1980'S-1990'S) PERIODS. 4. DEFINE OPTIONS FOR APOLLO 18 AND 19 MISSIONS (1974), AND 5. STUDY SPECIFIC PROBLEMS ASSOCIATED WITH APPLICATION OF LUNAR IMAGING, AND THE SCIENCE OF A LUNAR BASE.

RTOP NO. 981-20-50 TITLE: LUNAR BASE GEOSCIENCE PLANNING (USGS)

ORGANIZATION: NASA HEADQUARTERS

MONITOR: MOLLOY, M. W. TEL. 202-963-4882

TECHNICAL SUMMARY

AS JUSTIFICATION AND BACKGROUND FOR DECISIONS ON LUNAR "GAP FILLER" (1974-1980) AND LUNAR BASE (1980'S-1990'S) PROGRAMS, ASSIST NASA IN FORMULATING LUNAR EXPLORATION AND UTILIZATION PROGRAMS EMPHASIZING GEOSCIENCE OBJECTIVES, STRATEGY, REQUIREMENTS, SITES, AND TRAVERSES. UTILIZE CURRENT NASA PLANNING AND SCIENCE ADVISORY RECOMMENDATIONS AS A GUIDE FOR RESEARCH. DOCUMENT THE RESULTS FOR NASA, CENTER AND INDUSTRY STUDY.

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